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ENCYCLOPÆDIA BRITANNICA.

BURKE, Edmund, a writer, orator, and ſtateſman, was born in Dublin, on the 1ſt January, in the year 1730. His father was an attorney, firſt at Limerick, and afterwards in Dublin. Young Burke received the firſt rudiments of his education at Ballytore, in the county of Kildare, under the tuition of Abraham Shackleton, a Quaker of conſiderable celebrity. Committed to the care of a maſter ſo admirably qualified for the important buſineſs of inſtruction, young Burke applied to his ſtudies with commendable aſſiduity, and became one of the numerous examples that might be adduced, to demonſtrate the falſehood of that popular but dangerous maxim, *that young men of genius are always deſtitute of application.*

In this ſeminary he laid the foundation of his knowledge in the languages of antiquity; whence he was hereafter to borrow the elegance of his taſte, and the models and imagery of his eloquence. From this ſource was alſo, moſt probably, derived that love of liberty, which germinating at certain periods in his boſom, ſo often pointed his oratory, inflamed his paſſions, and animated his ſentiments; and which in his beſt days acquired him a reputation almoſt unequalled in our times.

At this reſpectable ſchool ſeveral years of his life were ſpent; and the attachment of the maſter, and the gratitude of the pupil, reflect honour on both. The former lived to ſee his ſcholar attain a conſiderable degree of reputation; and he on his part was accuſtomed to ſpend a portion of his annual viſit to Ireland at Ballytore.

From a provincial ſeminary Edmund was ſent to the univerſity of Dublin. Here, however, he does not appear to have diſtinguiſhed himſelf either by application or talents. His character, as a ſtudent, was merely negative. He exhibited no ſymptoms of early genius, obtained no palms in the academic race, and departed even without a degree. During this period, however, he commenced author. His firſt eſſays were of a political nature.

Mr Burke now addicted himſelf to other purſuits, particularly logic and metaphyſics; and is ſaid to have planned a refutation of the ſyſtems of Berkeley and Hume. While thus employed in treaſuring up the means of attaining a ſpecies of celebrity, which far different avocations prevented him afterwards from aſpiring to, he was not inattentive to the grand object of obtaining a ſuitable ſettlement in life; for his family was not opulent, and he already panted after independence. He accordingly became a candidate for a vacant chair at the univerſity of Glaſgow. The immediate reaſon of his failure is not directly known; but on this he repaired to the metropolis, and enrolled his name as a ſtudent of the Inner Temple.

It appears from his ſpeeches, his writings, and his converſation, that he ſtudied the grand outline of our municipal juriſprudence with particular attention; but it may be doubted whether he ever entered into the minutiæ. Indeed the verſatility of his talents, and his avocations, were but little calculated for that dull and plodding circuit which can alone lead to an intimate knowledge of our laws. Beſides, if he had been gifted with the neceſſary application, both time and opportunity were wanting: for it is well known that at this period of his life the “*res anguſta domi*” did not permit the ſtudent to dedicate his attention ſolely to this, or indeed to any other ſingle object.

The exhauſted ſtate of his finances called frequently for a ſpeedy ſupply, and inſtead of peruſing the pages of Bracton, Fleta, Littleton, and Coke, he was obliged to write eſſays, letters, and paragraphs, for the periodical publications of the day. But if theſe purſuits diverted his attention from graver ſtudies, they acquired him a facility of compoſition, and a command of ſtyle and of language, which proved eminently ſerviceable in the courſe of his future life.

His health, however, became at length impaired, and a nervous fever enſued. This circumſtance induced him to call in the aid of Dr Nugent, one of his own countrymen, a medical man whoſe manners were more amiable than his practice was extenſive. This gentleman, who had travelled on the continent, and was an author himſelf, readily diſcovered the ſource of his malady, and, by removing him from books and buſineſs to his own houſe, ſoon effected a cure. That event is ſaid to have been haſtened, if not entirely completed, by a phyſician of another kind; the accompliſhed daughter of his hoſt. This lady was deſtined to become his wife; a circumſtance particularly fortunate for him, as her diſpoſition was mild and gentle, and ſhe continued, through a long ſeries of years, and many viciſſitudes of fortune, to ſoothe and tranquillize paſſions always violent, and often tumultuous.

Our ſtudent ſeems at length to have determined once more to endeavour to diſtinguiſh himſelf as an author, and he accordingly took advantage of the death of a celebrated peer to write a work after the manner of that nobleman; in which, by exaggerating his principles, he ſhould be enabled to bring them into contempt: but this effort proved unſucceſsful, for the treatiſe in queſtion was for a long time conſigned to oblivion, and would never have been heard of, had it not been reſuſcitated by his future fame. Another performance made ample amends: his “ Eſſay on the Sublime and Beautiful” attracted a high degree of reputation, and acquired him conſiderable celebrity as a man of letters. In addition to the profits of the publication, he is ſaid on this occaſion to have received a preſent from his father of 100l. But his circumſtances muſt have been greatly embarraſſed about this time, as he was obliged to ſell his books; and ſurely nothing but the extremity of diſtreſs could have forced a man of letters to ſuch a meaſure.

The work we have juſt mentioned, having an immediate relation to taſte, excited a deſire in Sir Joſhua Reynolds, even then at the head of his profeſſion, to become acquainted with Mr Burke; and a friendſhip enſued which continued uninterrupted during the life of the painter, and was unequivocally teſtified by a handſome bequeſt in his will. Dr Johnſon alſo ſought and obtained an intimacy with him, and he now became the conſtant frequenter of two clubs, compoſed of ſome of the moſt celebrated men of that day. One of theſe met at the Turk's Head tavern in Gerrard-ſtreet, and conſiſted of the following members: Dr Johnſon, Mr (afterwards Sir Joſhua) Reynolds, Dr Goldſmith, Mr Topham Beauclerc, Dr Nugent, Sir John Hawkins, Mr Bennet Langton, Mr Chamier, Mr Garrick, and Mr Burke.

The other aſſembled at the St James's coffee-houſe, and beſides many of the above, was compoſed of the following members: Mr Cumberland, Dr Douglas biſhop of Saliſbury, Dr Bernard dean of Derry, Mr Richard Burke, Mr William Burke, Mr Hickey, &c. Dr Goldſmith, who was Mr Burke's contemporary at Dublin college, was a member of both, and wrote the epitaphs of thoſe who compoſed the latter. That on Mr Burke has often been praiſed.

Here lies our good Edmund, whoſe genius was ſuch,
We ſcarcely can praiſe it or blame it too much;
Who, born for the univerſe, narrow'd his mind,
And to party gave up what was meant for mankind.
Though fraught with all learning, yet ſtraining his throat
To perſuade Tommy Townſhend to lend him a vote;
Who, too deep for his hearers, ſtill went on refining,
And thought of convincing while they thought of dining;
Though equal to all things, for all things unfit,
Too nice for a ſtateſman, too proud for a wit;
For a patriot too cool; for a drudge diſobedient;
And too fond of the *right*, to purſue the *expedient*.
In ſhort, 'twas his fate, unemploy'd or in place, ſir,
To eat mutton cold, and cut blocks with a razor.

A literary work on a new plan, firſt ſuggeſted in 1750, and by ſome attributed to the Dodſleys, and by others to Mr Burke, became, for ſome time, a conſiderable ſource of emolument to him. This was called the “ Annual Regiſter;” a publication that ſoon obtained conſiderable celebrity, and of which he had the ſuperintendence for ſeveral years.

He was, at length, called off from his literary labours by avocations of a far different kind. A gentleman who afterwards derived the *cognomen* of “ ſingle-ſpeech Hamilton,” from a celebrated oration, having been appointed ſecretary to the lord-lieutenant of Ireland, invited his friend Mr Burke to accompany him thither; this offer he readily complied with, and although he acted in no public ſtation, and performed no public ſervice while he remained in that country, he was rewarded with a penſion of 300l. per annum, which he ſoon after diſpoſed of for a ſum of money.

On his return to England he amuſed himſelf, as uſual, with literary compoſition. A ſeries of eſſays, written by him in a newſpaper, which, at one time, obtained great celebrity, attracted the notice of the late marquis of Rockingham; and Mr Fitzherbert, a member of parliament, and father of the preſent Lord St Helen's, in conſequence of this circumſtance, introduced him to that nobleman. From this moment he was deſtined to become a public man, and to dedicate his ſtudies, his eloquence, and his pen, to politics.

Lord Rockingham having proved more compliant than the earl of Chatham, the former nobleman was brought into power, and ſeated on the treaſury bench. On this occaſion he ſelected Mr Burke as his private ſecretary, an office of no power and very little emolument, but which naturally leads to both. As it was now neceſſary he ſhould have a ſeat in parliament, although it cannot be ſuppoſed that he was legally qualified in reſpect to property, he applied to Lord Verney, who was patron of Wendover, a borough at that time dependent on him, and principally occupied by his tenants.

Having thus obtained a ſeat in 1765, he prepared to fit himſelf for his new ſituation. He was already provided with all the neceſſary talents, and was only deficient in the forms of buſineſs, and the facility of expreſſing his ſentiments before a public audience. The firſt of theſe was maſtered by ſedulous attention; and as to the ſecond, if we are to give credit to thoſe who pretend to be intimately acquainted with this period of his life, he overcame all difficulties by a previous initiation elſewhere. In ſhort he had acquired celebrity at the “ Robinhood,” before he attempted to ſpeak in the Britiſh ſenate, and vanquiſhed an eloquent “ baker” ere he began to cope with the great orators of the nation.

Holding a confidential place under the Rockingham adminiſtration, he of courſe ſupported all its meaſures. A former miniſtry, anxious to increaſe its influence by means of increaſed impoſts, had conceived the idea of taxing America through the medium of a parliament in which ſhe was not repreſentnd. Having attempted to carry this into effect by means of the famous ſtamp act, the Americans, alarmed at what they conceived to be a flagrant violation of every principle of the Engliſh conſtitution, made ſuch a ſpirited reſiſtance to the meaſure that it was abandoned, and the Rockingham party readily conſented to the repeal. Under the pretext, however, of vindicating the honour of the crown, they unfortunately propoſed and carried the declaratory act, by means of which, although the original ſcheme had been abandoned, the principle on which it was built was aſſerted anew, and a foundation laid for all the miſeries that afterwards enſued. But if this ſhort-lived adminiſtration deſerved no great credit on this occaſion, it is entitled to conſiderable praiſe on account of other parts of its conduct; for it repealed the cyder act, procured a declaration of the houſe of commons, condemning the ſeizure of papers, and a reſolution againſt general warrants. The firſt of theſe afforded great relief to ſuch of the counties as cultivated orchard grounds, and the two laſt ſeemed to be called for by the conduct of their predeceſſors in reſpect to Mr Wilkes.

On retiring from office they, however, did not carry much popularity along with them, as Lord Chatham and his friends, who in ſome meaſure monopolized the public favour, were entruſted with the management of affairs for a ſhort time; and it is extremely probable that they would have ſunk into neglect, had not America been driven into reſiſtance.

It now fell to the lot of Lord North to enforce the ſcheme which the Grenville party had projected, and wiſhed to carry boldly into execution; which the Rockingham adminiſtration had by an unaccountable blunder at once annihilated and recogniſed, and which they afterwards manfully, and at length ſucceſsfully oppoſed.

This forms the moſt brilliant epoch of Mr Burke's life. He was hoſtile to the expulſion of Mr Wilkes; an act which the houſe of commons afterwards reſcinded from its records. On the application of the diſſenters for relief, he took up their cauſe, and expreſſed his reſentment, in very animated terms, againſt that miſguided policy, which permits all thoſe not within the pale of eſtabliſhment to enjoy liberty leſs by right than by connivance. But perhaps the nobleſt part of his conduct conſiſted in his ſteady and uniform oppoſition to the American war, and his marked and declared hoſtility to the abettors of it. His ſpeech againſt the Boſton Port bill was one of the moſt charming ſpecimens of oratory that had ever been exhibited in the Britiſh ſenate; and on the 19th of April, 1774, on a motion for the repeal of the tea duty, he diſcovered ſuch talents, that an old and reſpectable member exclaimed, "Good God! what a man is this!—How could he acquire ſuch tranſcendent powers?" And when, in reply to another who had ſaid, "That the Americans were our children, and it was horrible to revolt againſt their parent!" the orator uttered the following paſſage, the whole houſe was electrified:—"They are our children, it is true; but when children aſk for bread, we are not to give them a ſtone. When thoſe children of ours wiſh to aſſimilate with their parent, and to reſpect the beauteous countenance of Britiſh liberty, are we to turn to them the ſhameful parts of our conſtitution? Are we to give them our weakneſs for their ſtrength; our opprobrium for their glory; and the ſlough of ſlavery, which we are not able to work off, to ſerve them for their freedom."

The city of Briſtol, the merchants of which had become rich by the commerce with America, were likely to ſuffer by its interdiction. This conſideration alone rendered many of them hoſtile to the proceedings of the miniſtry; but nobler and more exalted motives actuated the boſoms of others, particularly the Quakers, Diſſenters, and other ſectariſts, who were moved by zeal againſt oppreſſion, and a love of liberty imprinted on their minds by a conſtitution which had remained until then inviolate. Gratified by the exertions of Mr Burke in behalf of civil and religious freedom, they put him in nomination for their city, and ſent into Yorkſhire, to requeſt his immediate perſonal attendance. After conſulting with his patron concerning an offer ſo flattering and unexpected, accompanied at the ſame time with aſſurances moſt punctually fulfilled, *that he ſhould be put to no expence whatever*, he immediately ſet out for the weſt of England, and found that no leſs than three candidates had ſtarted before him. The firſt was Lord Clare, afterwards Lord Nugent, one of the former repreſentatives, whoſe unpopularity was ſuch, that he ſoon diſcovered the neceſſity of reſigning all his pretenſions; two, therefore (Mr Cruger and Mr Brickdale), only remained in the field, and the former of theſe, like Mr Burke himſelf, was averſe to a rupture with America.

The new candidate did not appear on the huſtings until the afternoon of the ſixth day's poll, on which occaſion he addreſſed the electors in a very able ſpeech, admirably calculated for the occaſion. He began by expreſſing a modeſt diffidence of his own abilities, and a high opinion of the important truſt they were aſſembled to confer. He then boldly declared himſelf hoſtile to a conteſt with America, and aſſerted, that England had been rendered flouriſhing by liberty and commerce, the firſt of which was dear to his heart, while the latter had been a favourite object of his ſtudies, both in its principles and details.

This harangue was well received by the electors; the conteſt proved propitious to his wiſhes; and when the ſheriffs had notified, at the cloſe of the poll, that he was elected, he made the moſt brilliant addreſs on the occaſion that had ever been heard within the walls of a city celebrated rather for its opulence than its eloquence.

Mr Burke immediately returned from his new conſtituents to parliament, with increaſed vigour, reputation, and zeal. The earl of Chatham, having failed, notwithſtanding his reputation for wiſdom, in an attempt to adjuſt the troubles of the colonies by means of a conciliatory bill introduced by him into the houſe of peers for that purpoſe, the obſtinacy of the miniſtry now became apparent to every one. This circumſtance, which would have appalled an inferior man, did not, however, diſcourage the member for Briſtol from a ſimilar attempt in another place; and accordingly, March 22. 1775, he brought forward his thirteen celebrated propoſitions, which were intended to cloſe the fatal breach, and heal all the differences between the mother country and her colonies.

His plan, on this occaſion, embraced not only an immediate conciliation, by a repeal of the late coercive acts, but alſo the creation of an independent judicature, and the regulation of the courts of admiralty. The whole, however, was quaſhed by a large majority on the ſide of the miniſter, who moved the previous queſtion.

Mr Burke had hitherto chiefly diſtinguiſhed himſelf in oppoſition to the meaſures of others; but in 1780, he himſelf ſtood forth as the original author and propoſer of a ſcheme which ſoon engaged the attention of the public, and actually appeared big with the moſt proſperous reſults. When he found miniſters obſtinately perſiſting in a diſaſtrous war, and perceived that the people began to bend beneath the weight of the taxes for its ſupport, it ſtruck him as advantageous on one hand, and political on the other, to diminiſh the public burdens and the number of adherents to the court at the ſame time. Accordingly, on the 11th of February, he brought in a bill "for the regulation of his majeſty's civil eſtabliſhments, and of certain public offices; for the limitation of penſions, and the ſuppreſſion of ſundry uſeleſs, expenſive, and inconvenient places, and for applying the monies ſaved thereby, to the public ſervice."

This ſcheme was manifeſtly founded on the late reforms that had taken place in France; for by an edict of the king, regiſtered in the parliament of Paris, it appeared that he had ſuppreſſed no leſs than 406 places in his houſehold by one regulation. The orator, with great judgment, faſtened upon this event, and endeavoured to make uſe of it as an incitement to a ſimilar attempt here; nay, he called in national rivalſhip itſelf, by way of an inducement to conſent to this ſacrifice on the part of the crown.

To this bill the minority did not at firſt give much oppoſition. Indeed the mover of it contrived to ſoften thoſe features that appeared harſh to them. Notwithſtanding this, it did not prove ſucceſsful during Lord North's adminiſtration; and when it was at length carried, it was much modified and altered.

Parliament was diſſolved in 1780, but Mr Burke was not re-elected for Briſtol, and this is ſaid to have made a deep impreſſion on the mind of the orator; but this muſt have been obliterated by the important events that ſpeedily enſued; for the miniſter now tottered on the treaſury bench, being abandoned by many of his ſtauncheſt ſupporters, and but little confident in his own ſchemes, all of which had proved eminently unſucceſsful. The oppoſition, having by this time increaſed to a conſiderable degree, unceaſingly aſſailed him, until at length, March 28. 1782, Lord North aſſured the houſe of commons, that his adminiſtration was at an end.

The day had now arrived when the miniſtry and oppoſition were to change places, and the former to be arrayed in the ſpoils of the latter. Of this rich booty Mr Burke, whoſe ſervices had been ſo conſpicuous in hunting the enemy into the toils prepared for them, had his portion: for he was made a privy counſellor, and inveſted with the lucrative appointment of paymaſter-general of the forces. He was at length now enabled to enforce his plan of political economy, tendered before in vain; and the board of trade, the board of works, the offices of third ſecretary of ſtate, treaſurer of the chamber, cofferer of the houſehold, the lords of police in Scotland, the maſter of the harriers, the maſter of the ſtag hounds, the ſix clerks of the board of green cloth, and the paymaſter of the penſions, were aboliſhed.

At length the reins of government were confided to the hands of the marquis of Lanſdowne, then earl Shelburne; and this event gave ſuch offence to thoſe who wiſhed to place the duke of Portland at the head of affairs, that Mr Fox, Lord John Cavendiſh, and Mr Burke, immediately reſigned.

In the mean time, the critical ſtate of the Engliſh Eaſt India Company had long agitated the public mind, and become occaſionally a ſubject of diſcuſſion in parliament. The ſeizure, impriſonment, and confinement of Lord Pigot, by a faction in the council of Madras; the conduct of Mr Haſtings, in reſpect to ſeveral of the native powers; the grand queſtion of ſovereignty, relative to the territorial poſſeſſions of the company in Aſia: all theſe ſubjects had, at different times, excited the attention of the nation.

No ſooner did Mr Fox behold himſelf and his friends in poſſeſſion of power, than he brought in a bill, to remedy the various abuſes in the government of Britiſh India. Of this bill Mr Burke is well known to have been the principal penman, and upon this occaſion he defended its principles and proviſions with all the zeal of a parent. In a ſpeech of conſiderable length he exhibited an able retroſpect of the ſyſtem, both political and commercial, of the company. He then proceeded to ſtate the benefit likely to reſult from the plan under contemplation, which he conſidered as calculated to effect "the reſcue of the greateſt number of the human race that ever were ſo grievouſly oppreſſed, from the greateſt tyranny that ever was exerciſed." In ſhort, he contemplated it as a meaſure that would "ſecure the rice in his pot to every man in India." "I carry my mind (adds he) to all the people, and all the names and deſcriptions that, relieved by this bill, will bleſs the labours of this parliament, and the confidence which the beſt houſe of commons has given to him who beſt deſerves it."

This celebrated bill, notwithſtanding much oppoſition both within and without, was carried triumphantly through the houſe of commons: but in the houſe of peers it experienced a far different fate, and with it fell the power and conſequence of its authors, framers, and ſupporters.

In the courſe of the next year (February 28. 1785), he made a celebrated ſpeech relative to the nabob of Arcot's debts; and depicted one of his creditors, who had taken an active ſhare in the late elections, "as a criminal who long ſince ought to have fattened the region kites with his offal; the old betrayer, inſulter, oppreſſor, and ſcourge, of a country (Tanjore), which had for years been an object of an unremitted, but unhappily an unequal, ſtruggle, between the bounties of Providence to renovate, and the wickedneſs of mankind to deſtroy."

But there appeared to Mr Burke to be a ſtill greater delinquent, on whom he was determined to inflict all the wounds of his eloquence, and ſacrifice, if poſſible, the powerful offender himſelf at the ſhrine of national vengeance. This was Mr Haſtings; and ſoon after his arrival in England, the orator gave notice of his intentions. On the 17th of February, 1785, he opened the accuſation by a moſt eloquent ſpeech; in which he depicted the ſuppoſed crimes of the late governor-general, in the moſt glowing and animated colours. This trial, however, turned out in the event far different from his hopes and expectations; while the length of it failed not to involve both himſelf and party in reproach.

During the debate on the commercial treaty with France (January 23. 1787), the member for Malton exhibited an undiminiſhed verſatility of talents, and pointed his ridicule with no common ſucceſs at Mr Pitt, who, according to him, contemplated the ſubject with a narrowneſs peculiar to limited minds:—"He ſeems to conſider it (adds he) as an affair of two little compting-houſes, and not of two great nations. He ſeems to conſider it as a contention between the ſign of the *fleur-de-lis* and the ſign of the old *red-lion*, for which ſhould obtain the beſt cuſtom."

The next public event of importance in which we find Mr Burke engaged, occurred in conſequence of his majeſty's indiſpoſition. On this occaſion he took an active part in the debates of the houſe of commons; and is ſuppoſed to have penned a letter for one, and a ſpeech for another, branch of the royal family. When Mr Pitt moved his declaratory reſolutions relative to the proviſional exerciſe of the royal authority, he attacked him with much aſperity of language, and was particularly ſevere on the manner in which the royal aſſent was to be given to all future acts of parliament. The men who held moſt of the high places under the government were treated as "jobbers, old hacks of the court, and the ſupporters and betrayers of all parties; and it was a mock crown, a tinſel robe, and a ſceptre from the theatre, lackered over and unreal," which were about to be conferred on the prince of Wales.

The oppoſition, leſſened indeed by a few occaſional deſertions, had hitherto acted as a great public body, ſuppoſed to be united in general principles, for the common welfare and proſperity of the ſtate; but the French revolution thinned their ranks, diſpelled their conſequence, and, by ſowing jealouſy between the chiefs, ſpread conſternation and diſmay among their followers.

It was on the 2d of March 1790, when Mr Fox moved for leave to bring in a bill to repeal the corporation and teſt-acts, that this diſunion became evident; and ſoon after this Mr Burke declared, "that his honourable friend and he were ſeparated in their politics for ever."

The miniſtry now ſeemed anxious to provide for their new aſſociate; and he, on his part, certainly appeared deſerving of ſome remuneration at their hands, for he had abandoned all his old friends, and not a few of his old principles. In addition to this, his "Reflections on the Revolution in France," had afforded ſome degree of countenance, and even popularity, to the meaſures of adminiſtration; and, not content with his own exertions, he had enliſted his ſon on the ſame ſide, and even ſent him to Coblentz. The royal munificence at length gratified his warmeſt wiſhes; for by a warrant, dated September 24. 1795, and made to commence January 5. 1793, he received a penſion of 1200l. for his own life, and that of his wife, on the civil liſt; while two other penſions of 2500l. a-year for three lives, payable out of the four and a half per cent. fund, dated October 24. 1795, were made to commence from July 24. 1793. Honours as well as wealth now ſeemed to await him, for he was about to be ennobled, when the untimely death of an only child put an end to his dreams of ambition, and contributed not a little to haſten his own, which occurred at his houſe at Beaconsfield, July 8. 1797.

Thus died, in the 68th year of his age, Edmund Burke, one of the greateſt orators, ſtateſmen, and authors, of his age; one whoſe name will long continue to be celebrated; and who, had he fallen during the meridian of his fame and character, would have ſcarcely been conſidered as ſecond to any man, either of ancient or modern times.

As a man of letters, he ranks high in point of genius, learning, and compoſition; and his works are attended with this peculiarity, that they are the production of almoſt the only orator of his day, who could wield his pen with as much fluency as his tongue, and ſhine equally in the ſenate and the cloſet. His diſſertation on the "Sublime and Beautiful" acquired him the applauſe of all, and ſecured him the friendſhip and aſſiſtance of many men of taſte in the nation. His political tracts betoken much reading, deep thought, uncommon ſagacity; and even thoſe who may be diſpoſed to object to his doctrines, cannot but admire his various talents, his happy alluſions, and his acute penetration. There is no ſpecies of compoſition which he has not attempted; no ſubject on which he has not occaſionally treated: his firſt and his laſt days were equally dedicated to literature, and he diſdained not any ſpecies of it, from the newſpaper column, that ſupplied needful bread to his early youth, to the more elaborate performance that procured unneceſſary opulence to his old age.

As an orator, notwithſtanding ſome glaring defects, he ſtands almoſt unrivalled. His geſticulation was at times violent and repulſive, his manner harſh and overbearing, his epithets coarſe and diſguſting; on many occaſions he made uſe of aſſertions which were not bottomed in fact, and on one in particular, toward the latter end of his life, had recourſe to ſtage trick and pantomime, inſtead of ſenſe and argument. But on the other hand, no man was better calculated to arouſe the dormant paſſions, to call forth the glowing affections of the human heart, and to "harrow up" the inmoſt receſſes of the ſoul. Venality and meanneſs ſtood appalled in his preſence; he who was dead to the feelings of his own conſcience, was ſtill alive to his animated reproaches; and corruption for a while became alarmed at the terrors of his countenance. His powers were never more conſpicuous than on that memorable day on which he expoſed the enormities of a ſubaltern agent of oriental deſpotiſm—on which he depicted the tortures inflicted by his orders, the flagrant injuſtice committed by his authority, the pollution that enſued in conſequence of his ſanction—when he painted agonizing nature vibrating in horrid ſuſpenſe between life and deſtruction—when he deſcribed, in the climax of crimes, "death introduced into the very ſources of life," the boſoms of his auditors became convulſed with paſſion, and thoſe of more delicate organs and weaker frame actually ſwooned away. Nay, after the ſtorm of eloquence had ſpent its force, and the captivated ears no longer liſtened to his voice, his features ſtill ſpoke the purpoſe of his heart, his hand ſtill ſeemed to threaten puniſhment, and his brow to meditate vengeance.

"The qualities of his heart (ſays one of his biographers) were not leſs amiable and eſtimable than his talents were aſtoniſhing:—benevolent, juſt, temperate, magnanimous. He loved his country, loved its conſtitution, becauſe he believed it the beſt adapted for its happineſs: at different times, from the ſame principle, he ſupported different members of it, when he thought the one or the other likely to be overbalanced. During the prevalence of the Bute plans, dreading the influence of the crown, he ſupported the people; and for the ſame reaſon, during the American war.

"After the overthrow of the French monarchy, the ariſtocracy, and the diſſemination in Great Britain of the principles that had deſtroyed theſe powers, apprehending ſimilar effects, if not vigorouſly oppoſed in England, he ſtrenuouſly ſupported the monarchy and ariſtocracy. Thus diſcriminately patriotic in public life, in his private relations his conduct was highly meritorious. A fond and attentive huſband, an affectionate and judiciouſly indulgent father, a ſincere friend, at once fervid and active, a liberal and kind maſter, an agreeable neighbour, a zealous and bountiful patron, he diffuſed light and happineſs. His principles were as ſtrict, and habits as virtuous, as his diſpoſitions were kind." (*Annual Necrology*).

BURKITT, William, a celebrated commentator on the New Teſtament, was born at Hitcham in Northamptonſhire, July 25. 1650, and educated at Pembroke hall, Cambridge. He entered young upon the miniſtry, being ordained by Biſhop Reynolds: and the firſt employment which he had was at Milden in Suffolk, where he continued 21 years a conſtant preacher, firſt as a curate, and afterwards as rector of that church. In the year 1692, he had a call to the vicarage of Dedham in Eſſex, where he continued to the time of his death, which happened in the latter end of October 1703. He was a pious and charitable man. He made great collections for the French Proteſtants in the years 1687, &c. and by his great care, pains, and charges, procured a worthy miniſter to go and ſettle in Carolina. Among other charities, by his laſt will and teſtament, he bequeathed the houſe wherein he lived, with the lands thereunto belonging, to be a habitation for the lecturer that ſhould be choſen from time to time to read the lecture at Dedham. Beſides his commentary upon the New Teſtament, written in the ſame plain, practical, and affectionate manner in which he preached, he wrote a volume, entitled *The poor man's help, and the rich man's guide.*

BURLAW. See *By-Law.*

BURLEIGH. See Cecil.

BURLESQUE, a ſpecies of compoſition, which, though a great engine of ridicule, is not confined to that ſubject; for it is clearly diſtinguiſhable into burleſque that excites laughter merely, and burleſque that excites deriſion or ridicule. A grave ſubject, in which there is no impropriety, may be brought down by a certain colouring ſo as to be riſible, as in Virgil traveſtie; the author firſt laughs at every turn in order to make his readers laugh. The Lutrin is a burleſque poem of the other ſort, laying hold of a low and trifling incident to expoſe the luxury, indolence, and contentious ſpirit, of a ſet of monks. Boileau, the author, turns the ſubject into ridicule, by dreſſing it in the heroic ſtyle, and affecting to conſider it as of the utmoſt dignity and importance. Though ridicule is the poet's aim, he always carries a grave face, and never once betrays a ſmile. The oppoſition between the ſubject and the manner of handling it, is what produces the ridicule; and therefore, in a compoſition of this kind, no image profeſſedly ludicrous ought to have quarter, becauſe ſuch images deſtroy the contraſt.

Though the burleſque that aims at ridicule produces its effects by elevating the ſtyle far above the ſubject; yet the poet ought to confine himſelf to ſuch images as are lively, and readily apprehended. A ſtrained elevation, ſoaring above the ordinary reach of fancy, makes not a pleaſant impreſſion. The mind is ſoon diſguſted by being kept long on the ſtretch. Machinery may be employed in a burleſque poem, ſuch as the Lutrin, Diſpenſary, or Hudibras, with more ſucceſs and propriety than in any other ſpecies of poetry. For burleſque poems, though they aſſume the air of hiſtory, give entertainment chiefly by their pleaſant and ludicrous pictures: It is not the aim of ſuch a poem to raiſe ſympathy; and for that reaſon, a ſtrict imitation of nature is not neceſſary. And hence, the more extravagant the machinery in a ludicrous poem, the more entertainment it affords.

BURLINGTON, a ſea-port town in the eaſt riding of Yorkſhire, ſituated on the German ocean, about 37 miles north-eaſt of York. E. Long. 0. 10. and N. Lat. 54. 15. It gave the title of earl to a branch of the noble family of Boyle, but the earldom is now extinct.

New-Burlington, the capital of New-Jerſey, in North America; ſituated in an iſland of Delaware river, about 20 miles north of Philadelphia. W. Long. 74. 0. N. Lat. 40. 40.

BURMAN, Francis, a Proteſtant miniſter, and learned profeſſor of divinity at Utrecht, was born at Leyden in 1628; and died on the 10th of November 1679, after having publiſhed a courſe of divinity, and ſeveral other works.

He is not to be confounded with *Francis Burman*, his ſon; or with *Peter Burman*, a laborious commentator on Phædrus, Lucan, Petronius, and other profane authors, who died in 1741.

BURN, in *Medicine* and *Surgery*, an injury received in any part of the body by fire. See Surgery.

BURNET, Gilbert, biſhop of Saliſbury in the latter end of the 17th century, was born at Edinburgh, in 1643, of an ancient family in the ſhire of Aberdeen. His father being bred to the law, was, at the reſtoration of King Charles II. appointed one of the lords of ſeſſion, with the title of *Lord Crimond*, in reward for his conſtant attachment to the royal party during the troubles of Great Britain. Our author, the youngeſt ſon of his father, was inſtructed by him in the Latin tongue: at ten years of age he was ſent to continue his ſtudies at Aberdeen, and was admitted M. A. before he was 14. His own inclination led him to the ſtudy of the civil and feudal law; and he uſed to ſay, that it was from this ſtudy he had received more juſt notions concerning the foundations of civil ſociety and government, than thoſe which ſome divines maintain. About the year after, he changed his mind, and began to apply to divinity, to the great ſatisfaction of his father. He was admitted preacher before he was 18; and Sir Alexander Burnet, his couſin-german, offered him a benefice; but he refuſed to accept of it.

In 1663, about two years after the death of his father, he came into England; and after ſix months ſtay at Oxford and Cambridge, returned to Scotland; which he ſoon left again to make a tour for ſome months, in 1664, in Holland and France. At Amſterdam, by the help of a Jewiſh rabbi, he perfected himſelf in the Hebrew language; and likewiſe became acquainted with the leading men of the different perſuaſions tolerated in that country; as Calviniſts, Arminians, Lutherans, Anabaptiſts, Browniſts, Papiſts, and Unitarians; amongſt each of which he uſed frequently to declare, he met with men of ſuch unfeigned piety and virtue, that he became fixed in a ſtrong principle of univerſal charity, and an invincible abhorrence of all ſeverities on account of religious diſſenſions.

Upon his return from his travels, he was admitted miniſter of Salton; in which ſtation he ſerved five years in the moſt exemplary manner. He drew up a memorial, in which he took notice of the principal errors in the conduct of the Scots biſhops, which he obſerved not to be conformable to the primitive inſtitution; and ſent a copy of it to ſeveral of them. This expoſed him to their reſentments: but, to ſhow he was not actuated with a ſpirit of ambition, he led a retired courſe of life for two years; which ſo endangered his health, that he was obliged to abate his exceſſive application to ſtudy. In 1669, he publiſhed his "Modeſt and free conference between a conformiſt and nonconformiſt." He became acquainted with the ducheſs of Hamilton, who communicated to him all the papers belonging to her father and her uncle; upon which he drew up the "Memoirs of the dukes of Hamilton." The duke of Lauderdale, hearing he was about this work, invited him to London, and introduced him to King Charles II. He returned to Scotland, and married the lady Margaret Kennedy, daughter of the earl of Caſſilis; a lady of great piety and knowledge, highly eſteemed by the Preſbyterians, to whoſe ſentiments ſhe was ſtrongly inclined. As there was ſome diſparity in their ages, that it might remain paſt diſpute that this match was wholly owing to inclination, and not to avarice or ambition, the day before their marriage our author delivered the lady a deed, whereby he renounced all pretenſions to her fortune, which was very conſiderable, and muſt otherwiſe have fallen into his hands, ſhe herſelf having no intention to ſecure it. The ſame year he publiſhed his "Vindication of the authority, conſtitution, and laws of the church and ſtate of Scotland;" which at that juncture was looked upon as ſo great a ſervice, that he was again offered a biſhopric, and a promiſe of the next vacant archbiſhopric; but did not accept of it, becauſe he could not approve of the meaſures of the court, the grand view of which he ſaw to be the advancement of Popery.

Mr Burnet's intimacy with the dukes of Hamilton and Lauderdale occaſioned him to be frequently ſent for by the king and the duke of York, who had converſations with him in private. But Lauderdale conceiving a reſentment againſt him on account of the freedom with which he ſpoke to him, repreſented at laſt to the king, that Dr Burnet was engaged in an oppoſition to his meaſures. Upon his return to London, he perceived that theſe ſuggeſtions had entirely thrown him out of the king's favour, though the duke of York treated him with greater civility than ever, and diſſuaded him from going to Scotland. Upon this, he reſigned his profeſſorſhip at Glaſgow, and ſtaid at London. About this time the living at Cripplegate being vacant, the dean and chapter of St Paul's (in whoſe gift it was), hearing of his circumſtances, and the hardſhips he had undergone, ſent him an offer of the benefice; but as he had been informed of their firſt intention of conferring it on Dr Fowler, he generouſly declined it. In 1675, at the recommendation of Lord Hollis, whom he had known in France, ambaſſador at that court, he was, by Sir Herbottle Grimſtone, maſter of the rolls, appointed preacher of the chapel there, notwithſtanding the oppoſition of the court. He was ſoon after choſen a lecturer of St Clement's, and became one of the preachers that were moſt followed in town. In 1697, he publiſhed his *Hiſtory of the Reformation*, for which he had the thanks of both houſes of parliament. The firſt part of it was publiſhed in 1679, and the ſecond in 1681. Next year he publiſhed an abridgment of theſe two parts.

Mr Burnet about this time happened to be ſent for to a woman in ſickneſs, who had been engaged in an amour with the earl of Rocheſter. The manner in which he treated her during her illneſs, gave that lord a great curioſity for being acquainted with him. Whereupon, for a whole winter, he ſpent one evening in a week with Dr Burnet, who diſcourſed with him upon all thoſe topics upon which ſceptics and men of looſe morals attack the Chriſtian religion. The happy effects of theſe conferences occaſioned the publication of his account of the life and death of that earl. In 1682, when the adminiſtration was changed in favour of the duke of York, being much reſorted to by perſons of all ranks and parties, in order to avoid returning viſits, he built a laboratory, and went for above a year through a courſe of chemical experiments. Not long after, he refuſed a living of 300l. a-year offered him by the earl of Eſſex, on the terms of his not reſiding there, but in London. When the inquiry concerning the popiſh plot was on foot, he was frequently ſent for and conſulted by King Charles with relation to the ſtate of the nation. His majeſty offered him the biſhopric of Chicheſter, then vacant, if he would engage in his intereſts; but he refuſed to accept it on theſe terms. He preached at the Rolls till 1684, when he was diſmiſſed by order of the court. About this time he publiſhed ſeveral pieces.

On King James's acceſſion to the throne, having obtained leave to go out of the kingdom, he firſt went to Paris, and lived in great retirement, till contracting an acquaintance with Brigadier Stouppe, a Proteſtant gentleman in the French ſervice, he made a tour with him into Italy. He met with an agreeable reception at Rome. Pope Innocent XI. hearing of our author's arrival, ſent the captain of the Swiſs guards to acquaint him he would give him a private audience in bed, to avoid the ceremony of kiſſing his holineſs's ſlipper. But Dr Burnet excuſed himſelf as well as he could. Some diſputes which our author had here concerning religion, beginning to be taken notice of, made it proper for him to quit the city, which, upon an intimation given him by Prince Borgheſe, he accordingly did.

He purſued his travels through Switzerland and Germany. In 1688, he came to Utrecht, with an intention to ſettle in ſome of the ſeven provinces. There he received an invitation from the prince and princeſs of Orange (to whom their party in England had recommended him) to come to the Hague, which he accepted. He was ſoon made acquainted with the ſecret of their councils, and adviſed the fitting out of a fleet in Holland ſufficient to ſupport their deſigns and encourage their friends. This, and the *Account of his Travels*, in which he endeavoured to blend Popery and tyranny together, and repreſent them as unſeparable, with ſome papers reflecting on the proceedings of England, that came out in ſingle ſheets, and were diſperſed in ſeveral parts of England, moſt of which Mr Burnet owned himſelf the author of, alarmed King James; and were the occaſion of his writing twice againſt him to the princeſs of Orange, and inſiſting, by his ambaſſador, on his being forbid the court; which, after much importunity was done, though he continued to be truſted and employed as before, the Dutch miniſter conſulting him daily. To put an end to theſe frequent conferences with the miniſters, a proſecution for high treaſon was ſet on foot againſt him both in England and Scotland. But Burnet receiving the news thereof before it arrived at the States, he avoided the ſtorm, by petitioning for, and obtaining without any difficulty, a bill of naturalization, in order to his intended marriage with Mary Scott, a Dutch lady of conſiderable fortune, who, with the advantage of birth, had thoſe of a fine perſon and underſtanding.

After his marriage with this lady, being legally under the protection of Holland, when Mr Burnet found King James plainly ſubverting the conſtitution, he omitted no method to ſupport and promote the deſign the prince of Orange had formed of delivering Great Britain, and came over with him in quality of chaplain. He was ſoon advanced to the ſee of Saliſbury. He declared for moderate meaſures with regard to the clergy, who ſcrupled to take the oaths, and many were diſpleaſed with him for declaring for the toleration of nonconformiſts. His paſtoral letter concerning the oaths of allegiance and ſupremacy to King William and Queen Mary, 1689, happening to touch upon the right of conqueſt, gave ſuch offence to both houſes of parliament, that it was ordered to be burnt by the hands of the common executioner. In 1698 he loſt his wife by the ſmall pox; and, as he was almoſt immediately after appointed preceptor to the duke of Glouceſter, in whoſe education he took great care, this employment, and the tender age of his children, induced him the ſame year to ſupply her loſs by a marriage with Mrs Berkely, eldeſt daughter of Sir Richard Blake, knight. In 1699 he publiſhed his Expoſition of the 39 articles; which occaſioned a repreſentation againſt him in the lower houſe of convocation in the year 1701; but he was vindicated in the upper houſe. His ſpeech in the houſe of lords in 1704 againſt the bill to prevent occaſional conformity was ſeverely attacked. He died in 1715, and was interred in the church of St James, Clerkenwell, where he has a monument erected to him. He formed a ſcheme for augmenting the poor livings; which he preſſed forward with ſuch ſucceſs, that it ended in an act of parliament paſſed in the ſecond year of Queen Anne, "for the augmentation of the livings of the poor clergy."

BURNET, *Thomas*, a polite and learned writer in the end of the 17th century, was born in Scotland, but educated in Cambridge under the tuition of Mr John Tillotſon, afterwards archbiſhop of Canterbury. In the beginning of 1685, he was made maſter of Sutton's hoſpital in London, after which he entered into holy orders. During the reign of King James, he made a noble ſtand in his poſt as maſter of the charter-houſe againſt the encroachments of that monarch, who would have impoſed one Andrew Popham, a Papiſt, as a penſioner upon the foundation of that houſe. In 1680 he publiſhed his *Telluris theoria ſacra*, ſo univerſally admired for the purity of the ſtyle and beauty of the ſentiments, that King Charles gave encouragement to a tranſlation of it into Engliſh. This theory was, however, attacked by ſeveral writers. In 1692 he publiſhed his *Archæologia philoſophica*, dedicated to King William, to whom he was clerk of the cloſet. He died in 1715. Since his death hath been publiſhed, his book *De ſtatu mortuorum et reſurgentium*, and his treatiſe *De fide et officiis Chriſtianorum*.

BURNET, the *Honourable James Lord Monboddo*, a ſenator of the college of juſtice in Scotland, was born about the year 1714. He was the ſon of Mr Burnet of Monboddo in Kincardineſhire. After paſſing through the uſual courſe of ſchool education, he proſecuted his ſtudies at the univerſities of Aberdeen, Edinburgh, and Leyden, with diſtinguiſhed reputation. He was admitted an advocate in 1737, and on the 12th of February 1767, he was raiſed to the bench by the title of Lord Monboddo, in the room of Lord Milton, appointed a judge the 4th of June 1742, and who had ſucceeded Sir John Lauder of Fountainhall, admitted November 1. 1689; being the third on the bench in ſucceſſion ſince the revolution.

He married Miſs Farquharſon, a very amiable woman, by whom he had a ſon and two daughters.

His private life was ſpent in the practice of all the ſocial virtues, and in the enjoyment of much domeſtic felicity. Although rigidly temperate in his habits of life, he, however, delighted much in the convivial ſociety of his friends, and among theſe he could number almoſt all the moſt eminent of thoſe who were diſtinguiſhed in Scotland for virtue, literature, or genuine elegance of converſation and manners. One of thoſe who eſteemed him the moſt was the late Lord Gardenſtone, a man who poſſeſſed no mean portion of the ſame overflowing benignity of diſpoſition, the ſame unimpeachable integrity as a judge, the ſame partial fondneſs for literature and the fine arts. His ſon, a very promiſing boy, in whoſe education he took great delight, was, indeed, ſnatched away from his affections by a premature death. But, when it was too late for ſorrow and anxiety to avail, the afflicted father ſtifled the emotions of nature in his breaſt, and wound up the energies of his ſoul to the firmeſt tone of ſtoical fortitude. He was, in like manner, bereaved of his excellent lady, the object of his deareſt tenderneſs; and he endured the loſs with a ſimilar firmneſs, fitted to do honour either to philoſophy or to religion. In addition to his office as a judge in the court of ſeſſion, an offer was made to him of a ſeat in the court of juſticiary. But, though the emoluments of this would have made a convenient addition to his income, he refuſed to accept it; leſt its buſineſs ſhould too much detach him from the purſuit of his favourite ſtudies. To theſe ſtudies he continued through the whole of a long life to be greatly devoted. His admiration of the manners, literature, and philoſophy of the ancients, was unbounded. Thus ſtrongly prepoſſeſſed, it is not to be wondered at, that the compariſon which he made between the ancients and moderns, was little favourable to the latter. For among the former he ſuppoſed that he ſaw all that was elegant, manly, and virtuous, all that was praiſeworthy and excellent; while the degenerate race of the moderns exhibited nothing but effeminacy and corruption.

The vacation of the court of ſeſſion afforded him ſufficient leiſure to retire every year, in ſpring and in autumn, to the country; and he uſed then to dreſs in a ſtyle of ſimplicity, as if he had been only a plain farmer; and to live among the people upon his eſtate, with all the kind familiarity and attention of an aged father among his grown-up children. Although his eſtate, from the old leaſes, afforded comparatively but a moderate income, he would never raiſe the rents, or diſplace an old tenant to make room for a new one who offered a higher rent. In imitation of the rural economy of ſome of the ancients, whom he chiefly admired, he accounted population the true wealth of an eſtate, and was deſirous of no improvement ſo much as of increaſing the number of ſouls upon his lands, ſo as to make it greater, in proportion to the extent, than that of thoſe upon the eſtate of any neighbouring landholder. It was there he had the pleaſure of receiving Dr Samuel Johnſon, with his friend James Boſwell, at the time when theſe two gentlemen were upon their well-known tour through the Highlands of Scotland. Johnſon admired nothing in literature ſo much as the diſplay of a keen diſcrimination of human character, a juſt apprehenſion of the principles of moral action, and that vigorous common ſenſe which is the moſt happily applicable to the ordinary conduct of life. Monboddo delighted in the refinements, the ſubtleties, the abſtractions, the affectations of literature; and in compariſon with theſe, deſpiſed the groſſneſs of modern taſte and of common affairs. Johnſon thought learning and ſcience to be little valuable, except ſo far as they could be made ſubſervient to the purpoſes of living uſefully and happily with the world, upon his own terms. Monboddo's favourite ſcience taught him to look down with contempt upon all ſublunary, and eſpecially upon all modern things; and to fit life to literature and philoſophy, not literature and philoſophy to life. James Boſwell, therefore, in carrying Johnſon to viſit Monboddo, probably thought of putting them one againſt another, as two game cocks, and promiſed himſelf much ſport from the colloquial conteſt which he expected to enſue between them. But Monboddo was too hoſpitable and courteous to enter into keen contention with a ſtranger in his own houſe. There was much talk between them, but no angry controverſy, no exaſperation of that diſlike for each other's well-known peculiarities with which they had met. Johnſon, it is true, ſtill continued to think Lord Monboddo what he called *a prig* in literature.

Lord Monboddo uſed frequently to viſit London, to which he was allured by the opportunity that great metropolis affords of enjoying the converſation of a vaſt number of men of profound erudition. A journey to the capital became a favourite amuſement of his periods of vacation from the buſineſs of the court to which he belonged; and, for a time, he made this journey twice a year. A carriage, a vehicle that was not in common uſe among the ancients, he conſidered as an engine of effeminacy and ſloth, which it was diſgraceful for a man to make uſe of in travelling. To be dragged at the tail of a horſe, inſtead of mounting upon his back, ſeemed, in his eyes, to be a truly ludicrous degradation of the genuine dignity of human nature. In all his journies, therefore, between Edinburgh and London, he was wont to ride on horſeback, with a ſingle ſervant attending him. He continued this practice, without finding it too fatiguing for his ſtrength, till he was upwards of eighty years of age. Within theſe few years, on his return from a laſt viſit, which he made on purpoſe to take leave, before his death, of all his old friends in London, he became exceedingly ill upon the road, and was unable to proceed; and had he not been overtaken by a Scotch friend, who prevailed upon him to travel the remainder of the way in a carriage, he might, perhaps, have actually periſhed by the way ſide, or breathed his laſt in ſome dirty inn. Since that time, he did not again attempt an equeſtrian journey to London.

In London, his viſits were exceedingly acceptable to all his friends, whether of the literary or faſhionable world. He delighted to ſhew himſelf at court; and the king is ſaid to have taken a pleaſure in converſing with the old man with a diſtinguiſhing notice that could not but be very flattering to him.

A conſtitution of body, naturally framed to wear well and laſt long, was ſtrengthened to Lord Monboddo by exerciſe, guarded by temperance, and by a tenor of mind too firm to be deeply broken in upon by thoſe paſſions which conſume the principles of life. In the country he always uſed much the exerciſes of walking in the open air, and of riding. The cold bath was a means of preſerving the health, to which he had recourſe in all ſeaſons, amid every ſeverity of the weather, under every inconvenience of indiſpoſition or buſineſs, with a perſeverance invincible. He was accuſtomed, alike in winter and in ſummer, to riſe at a very early hour in the morning, and, without loſs of time, to betake himſelf to ſtudy or wholeſome exerciſe. It is ſaid, that he even found the uſe of what he called the air bath, or the practice of occaſionally walking about, for ſome minutes, naked, in a room filled with freſh and cool air, to be highly ſalutary.

Lord Monboddo is well known to the world as a man of letters. His firſt publication was "a Diſſertation on the Origin and Progreſs of Language," in 2 vols. 8vo. 1773; which were followed by four more vols. the laſt publiſhed not long before his death. In this work, intended chiefly to vindicate the honours of *Grecian literature*, he aſcribes the origin of alphabetical writing to the Egyptians; and ſtrenuouſly maintains, that the ouran-outang is a claſs of the human ſpecies, and that his want of ſpeech is merely accidental. He al-

Burnet.

ſo endeavours to eſtabliſh the reality of the exiſtence of mermaids, and other fictitious animals. He was induced to undertake another work, for the purpoſe of defending the cauſe of Grecian philoſophy; and publiſhed, in five vols. 4to. a work entitled, "Antient Metaphyſics," which, like the other, is remarkable for a ſurpriſing mixture of erudition and genius, with the moſt abſurd whim and conceit.

As a judge, his deciſions were ſound, upright, and learned, and marked with acute diſcrimination; and free from thoſe paradoxes and partialities which appear in his writings. He attended his judicial duty with indefatigable diligence till within a few days of his death, which happened at his houſe in Edinburgh, May 26. 1799, at the advanced age of 85.

His eldeſt daughter married ſome years before his death. His ſecond daughter, in perſonal lovelineſs one of the fineſt women of the age, was beheld in every public place with general admiration, and was ſought in marriage by many ſuitors. Her mind was endowed with all her father's benevolence of temper, and with all his taſte for elegant literature, without any portion of his whim and caprice. It was her chief delight to be the nurſe and the companion of his declining age. Her preſence contributed to draw around him, in his houſe, and at his table, all that was truly reſpectable among the youth of his country. She mingled in the world of faſhion, without ſharing its follies; and heard thoſe flatteries which are addreſſed to youth and beauty, without being betrayed to that light and ſelfiſh vanity which is often the only ſentiment that fills the heart of the high-praiſed beauty. She delighted in reading, in literary converſation, in poetry, and in the fine arts, without contracting from this taſte, any of that pedantic ſelf-conceit and affectation which uſually characterize literary ladies, and whoſe preſence often frightens away the domeſtic virtues, the graces, the delicacies, and all the more intereſting charms of the ſex. When Burns, the well-known Scotiſh poet, firſt arrived from the plough in Ayrſhire to publiſh his poems in Edinburgh, there was none by whom he was more zealouſly patronized than by Lord Monboddo and his lovely daughter. No man's feelings were ever more powerfully or exquiſitely alive than thoſe of the ruſtic bard, to the emotions of gratitude, or to the admiration of the good and fair. In a poem which he at that time wrote, as a panegyrical addreſs to Edinburgh, he took occaſion to celebrate the beauty and excellence of Miſs Burnet, in, perhaps, the fineſt ſtanza of the whole:

> "Thy daughters bright thy walks adorns,
> "Gay as the gilded ſummer ſky,
> "Sweet as the dewy milk-white thorn,
> "Dear as the raptur'd thrill of joy!
> "Fair Burnet ſtrikes th' adoring eye;
> "Heav'n's beauties on my fancy ſhine,
> "I ſee the *Sire of Love* on high,
> "And own his work, indeed, divine."

She was the ornament of the elegant ſociety of the city in which ſhe reſided, her father's pride, and the comfort of his domeſtic life in his declining years. Every amiable and noble ſentiment was familiar to her heart, every female virtue was exemplified in her life. Yet, this woman, thus lovely, thus elegant, thus wiſe and virtuous, was cut off in the flower of her age, and left her father bereſt of the laſt tender tie which bound him to ſociety and to life. She died about ſix years before him of a conſumption; a diſeaſe that in Scotland proves too often fatal to the lovelieſt and moſt promiſing among the fair and the young. Neither his philoſophy, nor the neceſſary torpor of the feelings of extreme old age, were capable of preventing Lord Monboddo from being very deeply affected by ſo grievous a loſs; and from that time he began to droop exceedingly in his health and ſpirits. *Edin. Mag.*

Burnham Burning.

BURNET. See POTERIUM and SANGUISORBA, BOTANY *Index*.

BURNHAM, a market-town of Norfolk in England, ſituated in E. Long. 0. 50. N. Lat. 53. 0.

BURNING, the action of fire on ſome pabulum or fuel, by which the minute parts thereof are put into a violent motion, and ſome of them aſſuming the nature of fire themſelves, fly off *in orbem*, while the reſt are diſſipated in form of vapour or reduced to aſhes. See IGNITION.

Extraordinary Caſes of BURNING. We have inſtances of perſons burnt by fire kindled within their own bodies. A woman at Paris, who uſed to drink brandy to exceſs, was one night reduced to aſhes by a fire from within, all but her head and the ends of her fingers. Signora Corn. Zangari, or, as others call her, *Corn. Bandi*, an aged lady, of an unblemiſhed life, near Ceſana in Romagna, underwent the ſame fate in March 1731. She had retired in the evening to her chamber ſomewhat indiſpoſed; and in the morning was found in the middle of the room reduced to aſhes, all except her face, legs, ſkull, and three fingers. The ſtockings and ſhoes ſhe had on were not burnt in the leaſt. The aſhes were light; and, on preſſing between the fingers, vaniſhed, leaving behind a groſs ſtinking moiſture with which the floor was ſmeared; the walls and furniture of the room being covered with a moiſt cineritious ſoot, which had not only ſtained the linen in the cheſts, but had penetrated into the cloſet, as well as into the room overhead, the walls of which were moiſtened with the ſame viſcous humour.—We have various other relations of perſons burnt to death in this unaccountable manner.

Sig. Mondini, Bianchini, and Maffei, have written treatiſes expreſs to account for the cauſe of ſo extraordinary an event: common fire it could not be, ſince this would likewiſe have burnt the bed and the room; beſides that it would have required many hours, and a vaſt quantity of fuel, to reduce a human body to aſhes; and, after all, a conſiderable part of the bones would have remained entire, as they were anciently found after the fierceſt funeral fires. Some attribute the effect to a mine of ſulphur under the houſe; others to a miracle; while others ſuſpect that art of villany had a hand in it. A philoſopher of Verona maintains, that ſuch a conflagration might have ariſen from the inflammable matters wherewith the human body naturally abounds. Sig. Bianchini accounts for the conflagration of the lady above-mentioned, from her uſing a bath or lotion of camphorated ſpirit of wine when ſhe found herſelf out of order. Maffei ſuppoſes it owing to lightning, but to lightning generated in her own body, agreeable to his doctrine, which is, That lightning does not proceed from the clouds, but is always produced in the place where it is ſeen and its effects perceived. We have had a late attempt to eſtabliſh the opinion, that theſe deſtroying internal fires are cauſed in the entrails of the body by inflamed effluvia of the blood; by juices and fermentation in the ſtomach; by the many combuſtible matters which abound in living bodies for the purpoſes of life; and, finally, by the fiery evaporations which exhale from the ſettlings of ſpirit of wine, brandies, and other hot liquors, in the tunica villoſa of the ſtomach and other adipoſe or fat membranes; within which thoſe ſpirits engender a kind of camphor, which in the night time, in ſleep, by a full reſpiration, are put in a ſtronger motion, and are more apt to be ſet on fire. Others aſcribe the cauſe of ſuch perſons being ſet on fire to lightning; and their burning ſo entirely, to the greater quantity of phoſphorus and other combuſtible matter they contained.—For our own part, we can by no means pretend to explain the cauſe of ſuch a phenomenon: but for the intereſts of humanity, we wiſh it could be derived from ſomething external to the human body; for if, to the calamities of human life already known, we ſuperadd a ſuſpicion that we may unexpectedly, and without the leaſt warning, be conſumed by an *internal* fire, the thought is too dreadful to be borne.

Burning, or *Brenning*, in our old cuſtoms, denotes an infectious diſeaſe, got in the ſtews by converſing with lewd women, and ſuppoſed to be the ſame with what we now call the *venereal diſeaſe*.

In a manuſcript of the vocation of John Bale to the biſhopric of Oſſory, written by himſelf, he ſpeaks of Dr Hugh Weſton, who was dean of Windſor in 1556, but deprived by Cardinal Pole for adultery, thus: "At this day is leacherous Weſton, who is more practiſed in the arts of breech-burning, than all the whores of the ſtews. He not long ago brent a beggar of St Botolph's pariſh." See Stews.

Burning, in *Antiquity*, a way of diſpoſing of the dead, much practiſed by the ancient Greeks and Romans, and ſtill retained by ſeveral nations in the Eaſt and Weſt Indies. The antiquity of this cuſtom riſes as high as the Theban war, where we are told of the great ſolemnity accompanying this ceremony at the pyre of Menæacus and Archemorus, who were cotemporary with Jair the eighth judge of Iſrael. Homer abounds with funeral obſequies of this nature. In the inward regions of Aſia, the practice was of very ancient date, and the continuance long: for we are told, that, in the reign of Julian, the king of Chionia burnt his ſon's body, and depoſited the aſhes in a ſilver urn. Coeval almoſt with the firſt inſtances of this kind in the eaſt, was the practice in the weſtern parts of the world. The Herulians, the Getes, and the Thracians, had all along obſerved it; and its antiquity was as great with the Celtæ, Sarmatians, and other neighbouring nations. The origin of this cuſtom ſeems to have been out of friendſhip to the deceaſed: their aſhes were preſerved as we preſerve a lock of hair, a ring, or a ſeal, which had been the property of a deceaſed friend.

Kings were burnt in cloth made of the aſbeſtos ſtone, that their aſhes might be preſerved pure from any mixture with the fuel and other matters thrown on the funeral pile. The ſame method is ſtill obſerved with the princes of Tartary. Among the Greeks, the body was placed on the top of a pile, on which were thrown divers animals, and even ſlaves and captives, beſides unguents and perfumes. In the funeral of Patroclus we find a number of ſheep and oxen thrown in, then four horſes, followed by two dogs, and laſtly by 12 Trojan priſoners. The like is mentioned by Virgil in the funerals of his Trojans; where, beſides oxen, ſwine, and all manner of cattle, we find eight youths condemned to the flames. The firſt thing was the fat of the beaſts, wherewith the body was covered, that it might conſume the ſooner: it being reckoned great felicity to be quickly reduced to aſhes. For the like reaſon, where numbers were to be burnt at the ſame time, care was taken to mix with the reſt ſome of humid conſtitutions, and therefore more eaſily to be inflamed. Thus we are aſſured by Plutarch and Macrobius, that for every ten men it was cuſtomary to put in one woman. Soldiers uſually had their arms burnt with them. The garments worn by the living were alſo thrown on the pile, with other ornaments and preſents; a piece of extravagance which the Athenians carried to ſo great a height, that ſome of their lawgivers were forced to reſtrain them, by ſevere penalties, from defrauding the living by their liberality to the dead.—In ſome caſes, burning was expreſsly forbidden among the Romans, and even looked upon as the higheſt impiety. Thus infants, who died before the breeding of teeth, were intombed unburnt in the ground, in a particular place ſet apart for this purpoſe, called *ſuggrundarium*. The like was practiſed with regard to thoſe who had been ſtruck dead with lightning, who were never to be burnt again. Some ſay that burning was denied to ſuicides.—The manner of burning among the Romans was not unlike that of the Greeks; the corpſe, being brought out without the city, was carried directly to the place appointed for burning it; which, if it joined to the ſepulchre, was called *buſtum*; if ſeparate from it, *uſtrina*; and there laid on the *rogus* or *pyra*, a pile of wood prepared on which to burn it, built in ſhape of an altar, but of different height, according to the quality of the deceaſed. The wood uſed was commonly from ſuch trees as contain moſt pitch or roſin; and if any other were uſed, they ſplit it, for the more eaſy catching fire: round the pile they ſet cypreſs trees, probably to hinder the noiſome ſmell of the corpſe. The body was not placed on the bare pile, but on the couch or bed whereon it lay. This done, the next of blood performed the ceremony of lighting the pile; which they did with a torch, turning their faces all the while the other way, as if it were done with reluctance. During the ceremony, decurſions and games were celebrated; after which came the *oſſilegium*, or gathering of the bones and aſhes; alſo waſhing and anointing them, and repoſiting them in urns.

Burning, among ſurgeons, denotes the application of an actual cautery, that is, a red-hot iron inſtrument, to the part affected; otherwiſe denominated *cauterization*. The whole art of phyſic among the Japaneſe lies in the choice of places proper to be burnt: which are varied according to the diſeaſe. In the country of the Mogul, the colic is cured by an iron ring applied red-hot about the patient's navel. Certain it is, that ſome very extraordinary cures have been performed accidentally by burning. The following caſe is recorded in the Memoirs of the academy of ſciences by M. Homberg. A woman of about 35 became ſubject to a headach, which at times was ſo violent that it drove her out of her ſenſes, making her ſometimes ſtupid and fooliſh, at other times raving and furious. The ſeat of the pain was in the forehead, and over the eyes, which were inflamed, and looked violently red and ſparkling; and the moſt violent fits of it were attended with nauſeas and vomitings. In the times of the fits, ſhe could take no food; but out of them, had a very good ſtomach. Mr Homberg had in vain attempted her cure for three years with all kinds of medicines: only opium ſucceeded; and that but little, all its effect being only the taking off the pain for a few hours. The redneſs of her eyes was always the ſign of an approaching fit. One night, feeling a fit coming on, ſhe went to lie down upon the bed; but firſt walked up to the glaſs with the candle in her hand, to ſee how her eyes looked: in obſerving this, the candle ſet fire to her cap: and as ſhe was alone, her head was terribly burnt before the fire could be extinguiſhed. Mr Homberg was ſent for, and ordered bleeding and proper dreſſings: but it was perceived, that the expected fit this night never came on; the pain of the burning wore off by degrees; and the patient found herſelf from that hour cured of the headach, which had never returned in four years after, which was the time when the account was communicated. Another caſe, not leſs remarkable than the former, was communicated to Mr Homberg by a phyſician at Bruges. A woman, who for ſeveral years had her legs and thighs ſwelled in an extraordinary manner, found ſome relief from rubbing them before the fire with brandy every morning and evening. One evening the fire chanced to catch the brandy ſhe had rubbed herſelf with, and ſlightly burnt her. She applied ſome brandy to her burn; and in the night all the water her legs and thighs were ſwelled with was entirely diſcharged by urine, and the ſwelling did not again return.

Burning-Buſh. See Bush.

Burning Glaſs, a convex glaſs commonly ſpherical, which being expoſed directly to the ſun, collects all the rays falling thereon into a very ſmall ſpace called the *focus;* where wood or any other combuſtible matter being put, will be ſet on fire. The term *burning-glaſs* is alſo uſed to denote thoſe concave mirrors, whether compoſed of glaſs quickſilvered, or of metalline matters, which burn by reflection, condenſing the ſun's rays into a focus ſimilar to the former.

The uſe of burning-glaſſes appears to have been very ancient. Diodorus Siculus, Lucian, Dion, Zonaras, Galen, Anthemius, Euſtathius, Tzetzes, and others, atteſt, that by means of them Archimedes ſet fire to the Roman fleet at the ſiege of Syracuſe. Tzetzes is ſo particular in his account of this matter, that his deſcription ſuggeſted to Kircher the method by which it was probably accompliſhed. That author ſays, that "Archimedes ſet fire to Marcellus's navy, by means of a burning glaſs compoſed of ſmall ſquare mirrors moving every way upon hinges; which, when placed in the ſun's rays, directed them upon the Roman fleet, ſo as to reduce it to aſhes at the diſtance of a bow ſhot." A very particular teſtimony we have alſo from Anthemius of Lydia, who takes pains to prove the poſſibility of ſetting fire to a fleet, or any other combuſtible body, at ſuch a diſtance.

That the ancients were alſo acquainted with the uſe of catoptric or refracting burning-glaſſes, appears from a paſſage in Ariſtophanes's comedy of The Clouds, which clearly treats of their effects. The author introduces Socrates as examining Strepſiades about the method he had diſcovered of getting clear of his debts. He replies, that "he thought of making uſe of a burning-glaſs which he had hitherto uſed in kindling his fire;" "for (ſays he) ſhould they bring a writ againſt me, I'll immediately place my glaſs in the ſun at ſome little diſtance from it, and ſet it on fire." Pliny and Lactantius have alſo ſpoken of glaſſes that burn by refraction. The former calls them *balls* or *globes of glaſs* or *cryſtal*, which, expoſed to the ſun, tranſmit a heat ſufficient to ſet fire to cloth, or corrode the dead fleſh of thoſe patients who ſtand in need of cauſtics; and the latter, after Clemens Alexandrinus, takes notice that fire may be kindled by interpoſing glaſſes filled with water between the ſun and the object, ſo as to tranſmit the rays to it.

It ſeems difficult to conceive how they ſhould know ſuch glaſſes would burn without knowing they would magnify, which it is granted they did not, till towards the cloſe of the 13th century, when ſpectacles were firſt thought on. For as to thoſe paſſages in Plautus which ſeem to intimate the knowledge of ſpectacles, M. de la Hire obſerves, they do not prove any ſuch thing; and he ſolves this, by obſerving, that their burning-glaſſes being ſpheres, either ſolid or full of water, their foci would be one-fourth of their diameter diſtant from them. If then their diameter were ſuppoſed half a foot, which is the moſt we can allow, an object muſt be at an inch and a half diſtance to perceive it magnified; thoſe at greater diſtances do not appear greater, but only more confuſed through the glaſs than out of it. It is no wonder, therefore, the magnifying property of convex glaſſes was unknown, and the burning one known. It is more wonderful there ſhould be 300 years between the invention of ſpectacles and teleſcopes.

Among the ancients, the burning mirrors of Archimedes and Proclus are famous: the former we have already taken notice of; by the other, the navy of Vitellius beſieging Byzantium, according to Zonaras, was burnt to aſhes.

Among the moderns, the moſt remarkable burning mirrors are thoſe of Settala, of Villette, of Tſchirnhauſen, of Buffon, of Trudaine, and of Parker.

Settala, canon of Padua, made a parabolic mirror, which, according to Schottus, burnt pieces of wood at the diſtance of 15 or 16 paces. The following things are noted of it in the *Acta Eruditorum.* 1. Green wood takes fire inſtantaneouſly, ſo as a ſtrong wind cannot extinguiſh it. 2. Water boils immediately; and eggs in it are preſently edible. 3. A mixture of tin and lead, three inches thick, drops preſently; and iron and ſteel plate becomes red-hot preſently, and a little after burns into holes. 4. Things not capable of melting, as ſtones, bricks, &c. become ſoon red-hot, like iron. 5. Slate becomes firſt white, then a black glaſs. 6. Tiles are converted into a yellow glaſs, and ſhells into a blackiſh yellow one. 7. A pumice ſtone, emitted from a volcano, melts into white glaſs; and, 8. A piece of crucible alſo vitrifies in eight minutes. 9. Bones are ſoon turned into an opaque glaſs, and earth into a black one. The breadth of this mirror is near three Leipſic ells, its focus two ells from it; it is made of copper, and its ſubſtance is not above double the thickneſs of the back of a knife.

Villette, a French artiſt of Lyons, made a large mirror, which was bought by Tavernier and preſented to the king of Perſia; a ſecond, bought by the king of Denmark; a third, preſented by the French king to the Royal Academy; a fourth has been in England, where it was publicly expoſed. The effects hereof, as found by Dr Harris and Dr Deſaguliers, are, that a ſilver ſixpence is melted in 7½″, a King George's halfpenny in 16″, and runs with a hole in 34. Tin melts in 3″, caſt iron in 16″, ſlate in 3″; a foſſil ſhell calcines in 7″; a piece of Pompey's pillar at Alexandria vitrifies, the black part in 50″, in the white in 54″; copper ore in 8″; bone calcines in 4″, vitrifies in 33″. An emerald melts into a ſubſtance like a turquois ſtone; a diamond weighing four grains loſes ⅞ of its weight: the aſbeſtos vitrifies; as all other bodies will do, if kept long enough in the focus; but when once vitrified, the mirror can go no farther with them. This mirror is 47 inches wide, and is ground to a ſphere of 76 inches radius; ſo that its focus is about 38 inches from the vertex. Its ſubſtance is a compoſition of tin, copper, and tin-glaſs.

Every lens, whether convex, plano-convex, or convexo-convex, collects the ſun's rays, diſperſed over its convexity, into a point by refraction; and is therefore a burning glaſs. The moſt conſiderable of this kind is that made by M. de Tſchirnhauſen: the diameters of his lenſes are three and four feet, the focus at the diſtance of 12 feet, and its diameter an inch and a half. To make the focus the more vivid, it is collected a ſecond time by a ſecond lens parallel to the firſt, and placed in that point where the diameter of the cone of rays formed by the firſt lens is equal to the diameter of the ſecond; ſo that it receives them all; and the focus, from an inch and a half, is contracted into the ſpace of eight lines, and its force increaſed proportionably.

This glaſs vitrifies tiles, ſlates, pumice-ſtones, &c. in a moment. It melts ſulphur, pitch, and all roſins, under water; the aſhes of vegetables, woods, and other matters, are tranſmuted into glaſs; and every thing applied to its focus is either melted, turned into a calx, or into ſmoke. Tſchirnhauſen obſerves, that it ſucceeds beſt when the matter applied is laid on a hard charcoal well burnt.

Sir Iſaac Newton preſented a burning-glaſs to the royal ſociety, conſiſting of ſeven concave glaſſes, ſo placed as that all their foci join in one phyſical point. Each glaſs is about 11 inches and a half in diameter: ſix of them are placed round the ſeventh, to which they are all contiguous; and they form a kind of ſegment of a ſphere, whoſe ſubtenſe is about 34 inches and a half, and the central glaſs lies about an inch farther in than the reſt. The common focus is about 22 inches and a half diſtant, and about an inch in diameter. This glaſs vitrifies brick or tile in 1″, and melts gold in 30″.

It would appear, however, that glaſs quickſilvered is a more proper material for burning-glaſſes than metals; for the effects of that ſpeculum wherewith Mr Macquer melted the platina ſeem to have been ſuperior to thoſe above mentioned, though the mirror itſelf was much ſmaller. The diameter of this glaſs was only 22 inches, and its focal diſtance 28. Black flint, when expoſed to the focus, being powdered to prevent its crackling and flying about, and ſecured in a large piece of charcoal, bubbled up and ran into tranſparent glaſs in leſs than half a minute. Heſſian crucibles, and glaſs-houſe pots, vitrified completely in three or four ſeconds. Forged iron ſmoked, boiled, and changed into a vitreſcent ſcoria as ſoon as it was expoſed to the focus. The gypſum of Montmartre, when the flat ſides of the plates or leaves of which it is compoſed were preſented to the glaſs, did not ſhow the leaſt diſpoſition to melt; but, on preſenting a tranſverſe ſection of it, or the edges of the plates, it melted in an inſtant, with a hiſſing noiſe, into a browniſh yellow matter. Calcareous ſtones did not completely melt: but there was detached from them a circle more compact than the reſt of the maſs, and of the ſize of the focus; the ſeparation of which ſeemed to be occaſioned by the ſhrinking of the matter which had begun to enter into fuſion. The white calx of antimony, commonly called *diaphoretic antimony*, melted better than the calcareous ſtones, and changed into an opaque pretty gloſſy ſubſtance like white enamel. It was obſerved, that the whiteneſs of the calcareous ſtones and the antimonial calx was of great diſadvantage to their fuſion, by reaſon of their reflecting great part of the ſun's rays; ſo that the ſubject could not undergo the full activity of the heat thrown upon it by the burning-glaſs. The caſe was the ſame with metallic bodies; which melted ſo much the more difficultly as they were more white and poliſhed; and this difference was ſo remarkable, that in the focus of this mirror, ſo fuſible a metal as ſilver, when its ſurface was poliſhed, did not melt at all.

Plate CXXXI. fig. 1. repreſents M. Buffon's burning mirror, which he with great reaſon ſuppoſes to be of the ſame nature with that of Archimedes. It conſiſts of a number of ſmall mirrors of glaſs quickſilvered, all of which are held together by an iron frame. Each of theſe ſmall mirrors is alſo moveable by a contrivance on the back part of the frame, that ſo their reflections may all coincide in one point. By this means they are capable of being accommodated to various heights of the ſun, and to different diſtances. The adjuſting them in this manner takes up a conſiderable time; but after they are ſo adjuſted, the focus will continue unaltered for an hour or more.

Fig. 2. repreſents a contrivance of M. Buffon's for diminiſhing the thickneſs of very large refracting lenſes. He obſerves, that in the large lenſes of this kind, and which are moſt convenient for many purpoſes, the thickneſs of the glaſs in the middle is ſo great as very much to diminiſh their force. For this reaſon he propoſes to form a burning-glaſs of concentric circular pieces of glaſs, each reſting upon the other, as repreſented in the figure. His method is to divide the convex arch of the lens into three equal parts. Thus, ſuppoſe the diameter to be 26 inches, and the thickneſs in the middle to be three inches: By dividing the lens into three concentric circles, and laying the one over the other, the thickneſs of the middle piece needs be only one inch; at the ſame time that the lens will have the ſame convexity, and almoſt the ſame focal diſtance, as in the other caſe; while the effects of it muſt be much greater, on account of the greater thinneſs of the glaſs.

M. Trudaine, a French gentleman, conſtructed a burning lens on a new principle. It was compoſed of two circular ſegments of glaſs ſpears, each four feet in diameter, applied with their concave ſides towards each other. The cavity was filled with ſpirit of wine, of which it contained 40 pints. It was preſented by the maker to the royal academy of ſciences, but was, not long after, broken by accident. The expence of conſtructing it amounted to about 1000l. ſterling. After all, it does not appear that the effects of this lens were very great. Mr Magellan informs us, that it could only coagulate the particles of platina in 20 minutes, while Mr Parker's lens entirely melted them in leſs than two.

A large burning lens, indeed, for the purpoſe of fuſing and vitrifying ſuch ſubſtances as reſiſt the fires of ordinary furnaces, and eſpecially for the application of heat in vacuo, and in other circumſtances in which heat cannot be applied by any other means, has long been a deſideratum among perſons concerned in philoſophical experiments: And it appears now to be in a great degree accompliſhed by Mr Parker. His lens is three feet in diameter, made of flint-glaſs, and which, when fixed in its frame, expoſes a ſurface two feet eight inches and a half in the clear.

In the *Elevation* repreſented on Plate CXXXII, A is the lens of the diameter mentioned: thickneſs in the centre, three inches and one-fourth: weight, 212 pounds: length of the focus, ſix feet eight inches; diameter of ditto, one inch. B, a ſecond lens, whoſe diameter in the frame is 16 inches, and ſhows in the clear 13 inches: thickneſs in the centre, one inch five-eighths: weight 21 pounds: length of focus 29 inches: diameter of ditto, three-eighths of an inch. When the two above lenſes are compounded together, the length of the focus is five feet three inches: diameter of ditto, half an inch. C, a truncated cone, compoſed of 21 ribs of wood: at the larger end is fixed the great lens A; at the ſmaller extremity the leſſer lens B: near the ſmaller end is alſo fixed a rack, D, paſſing through the pillar L, moveable by a pinion turning in the ſaid pillar, by means of the handle E, and thus giving a vertical motion to the machine. F, a bar of wood, fixed between the two lower ribs of the cone at G; having, within a chafed mortice in which it moves, an apparatus H, with the iron plate, I, fixed thereto; and this part turning on a ball and ſocket, K, a method is thereby obtained of placing the matter under experiment, ſo as to be acted upon by the focal rays in the moſt direct and powerful manner. LL, a ſtrong mahogany frame, moving on caſtors, MM. Immediately under the table N are three friction wheels, by which the machine moves horizontally. O, a ſtrong iron bow, in which the lens and the cone hang.

Section. a, The great lens marked A in the elevation. b, The frame which contains the lens. e, The ſmall lens marked B. d, The frame which contains the ſmall lens. e, The truncated cone, marked C. f, The bar on which the apparatus marked F moves. g, The iron plate marked I. h, The cone of rays formed by the refraction of the great lens a, and falling on the lens c. i, The cone of rays formed by the refraction of the lens c, *Front-view.* k, The great lens. l, The frame containing it. m, The ſtrong iron bow in which it hangs.

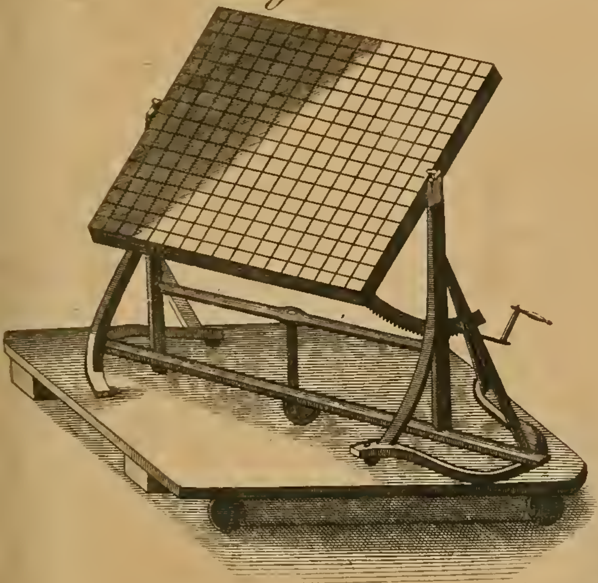
From a great number of experiments made with this lens, in the preſence of many ſcientific perſons, the following are ſelected as ſpecimens of its powers.

Subſtances fuſed, with their weight and time of fuſion.	Weight in Grains.	Time in Seconds.
Gold, pure, - - -	20	3
Silver, do. - - -	20	4
Copper, do. - - -	33	20
Platina, do. - - -	10	3
Nickell, - - - -	16	3
Bar iron, a cube, - - -	10	12
Caſt iron, a cube, - - -	10	3
Steel, a cube, - - - -	10	12
Scoria of wrought iron, - -	12	2
Terra ponderoſa or barytes, - -	10	7
A topaz, or chryſolite, -	3	45
An oriental emerald, - - -	2	25
Cryſtal pebble, - - -	7	6
White agate, - - - -	10	30
Flint, oriental, - - -	10	30
Rough cornelian, - - -	10	75
Jaſper, - - -	10	25
Onyx, - - - -	10	20
Garnet, - - -	10	17
White rhomboidal ſpar, - -	10	60
Zeolites, - - - -	10	23
Rotten ſtone, - - -	10	80
Common ſlate, - - - -	10	2
Aſbeſtos, - - -	10	10
Common lime-ſtone, - - -	10	55
Pumice-ſtone, - - -	10	24
Lava, - - - -	10	7
Volcanic clay, - - -	10	60
Corniſh moor ſtone, - - -	10	60

Burning Mountains. See ÆTNA, HECLA, VESUVIUS, and VO[illegible]O, with the plates accompanying them.

Burning Springs. Of theſe there are many in different parts of the world; particularly one in Dauphiny near Grenoble; another near Hermanſtadt in Tranſylvania; a third at Chermay, a village near Switzerland; a fourth in the canton of Friburg; and a fifth not far from the city of Cracow in Poland. There alſo is, or was, a famous ſpring of the ſame kind at Wigan in Lancaſhire, which, upon the approach of a lighted candle, would take fire and burn like ſpirit of wine for a whole day. But the moſt remarkable one of this kind, or at leaſt that of which we have the moſt particular deſcription, was diſcovered in 1711 at Broſely in Shropſhire. The following account of this remarkable ſpring was given by the reverend Mr Maſon, Woodwardian profeſſor at Cambridge, dated February 18. 1746. "The well for four or five feet deep is ſix or ſeven feet wide; within that is another leſs hole of like depth dug in the clay, in the bottom whereof is placed a cylindric earthen veſſel, of about four or five inches diameter at the mouth, having the bottom taken off, and the ſides well fixed in the clay rammed

Burning Mirror
of Archimedes.
Fig. 1.



Burning Mirror
with elevations.
Fig. 2.

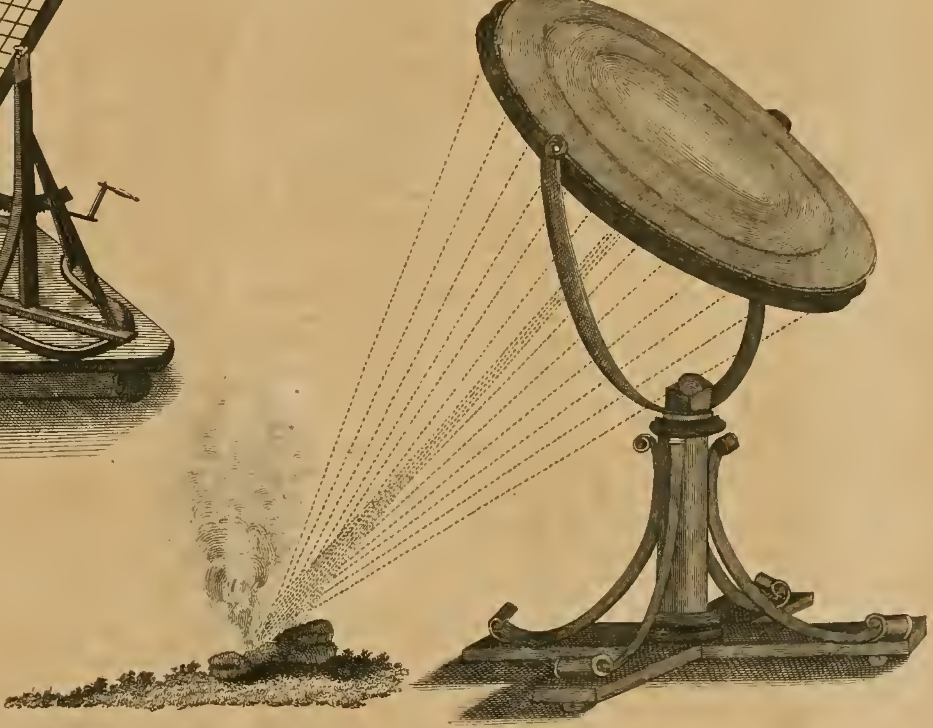


Fig. 3.

Burrough's Machine
for polishing Glass.

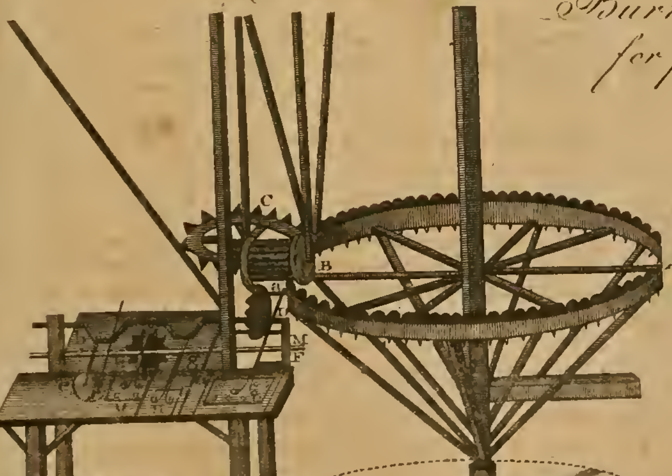
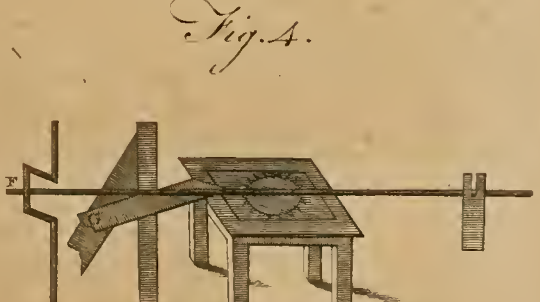


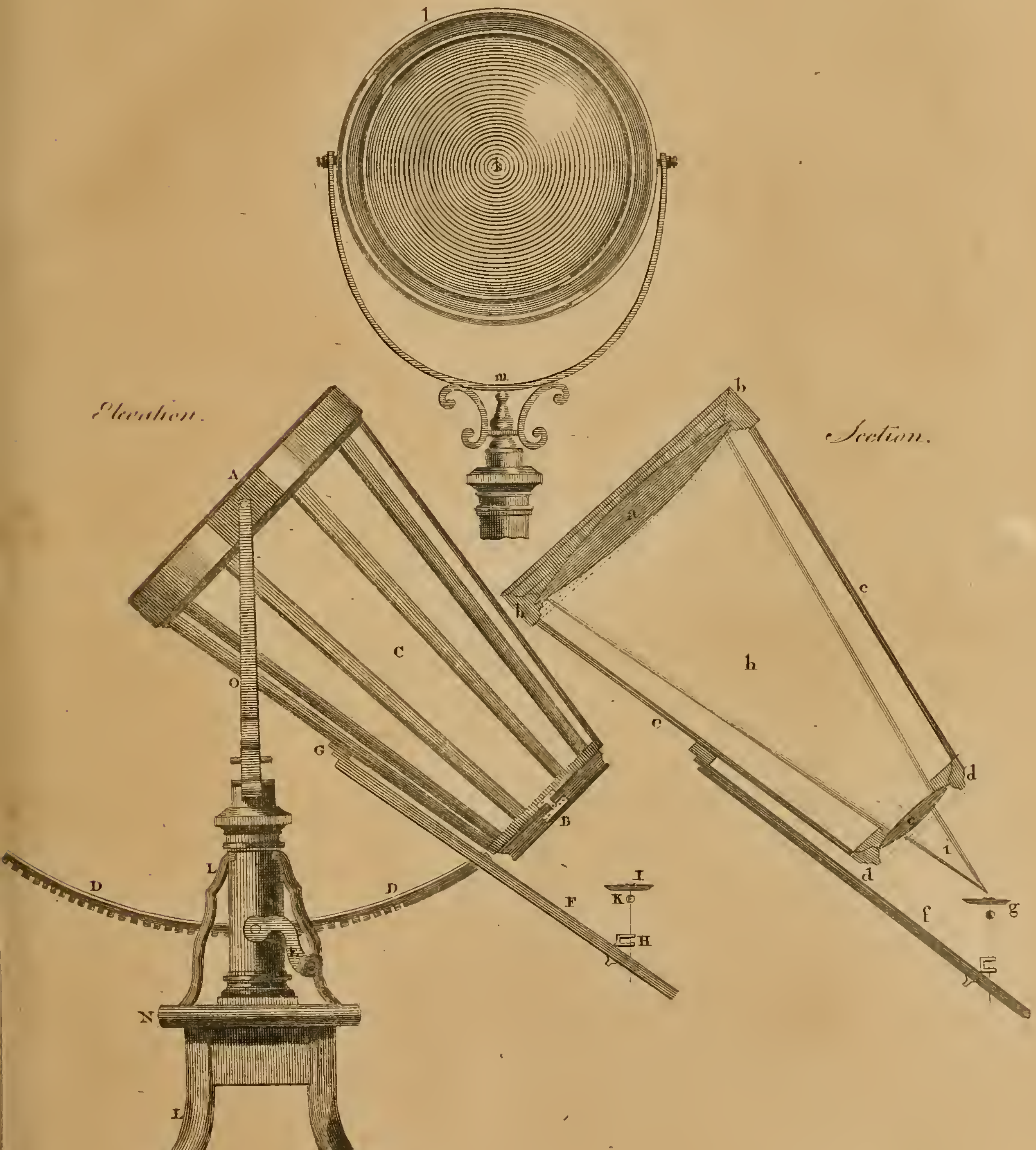
Fig. 4.



A. Bell Prin. Wal. Sculptor fecit.

BURNING Lens.
Parker's.

Plate CXXXII.



J. Bell Prin. Maj. Sculptor fecit.

rammed cloſe about it. Within the pot is a brown water, thick as puddle, continually forced up with a violent motion beyond that of boiling water, and a rumbling hollow noiſe, riſing or falling by fits five or ſix inches; but there was no appearance of any vapour riſing, which perhaps might have been viſible, had not the ſun ſhone ſo bright. Upon putting a candle down at the end of a ſtick, at about a quarter of a yard diſtance, it took fire, darting and flaſhing after a very violent manner for about half a yard high, much in the manner of ſpirits in a lamp, but with great agitation. It was ſaid, that a tea-kettle had been made to boil in about nine minutes time, and that it had been left burning for 48 hours without any ſenſible diminution. It was extinguiſhed by putting a wet mop upon it; which muſt be kept there for a little time, otherwiſe it would not go out. Upon the removal of the mop there ariſes a ſulphureous ſmoke laſting about a minute, and yet the water is very cold to the touch." In 1755, this well totally diſappeared by the ſinking of a coal-pit in its neighbourhood.

The cauſe of the inflammable property of ſuch waters is, with great probability, ſuppoſed to be their mixture with petroleum, which is a very inflammable ſubſtance, and has the property of burning on the ſurface of water.

Burning of Colours, among painters. There are ſeveral colours that require burning; as,

Firſt, Lamp-black, which is a colour of ſo greaſy a nature, that, except it is burnt, it will require a long time to dry. The method of burning, or rather drying, lamp black, is as follows: Put it into a crucible over a clear fire, letting it remain till it be red hot, or ſo near it that no manner of ſmoke ariſes from it.

Secondly, Umber, which if it be intended for colour for a horſe, or to be a ſhadow for gold, then burning fits it for both theſe purpoſes. In order to burn umber, you muſt put it into the naked fire, in large lumps, and not take it out till it is thoroughly red hot; if you have a mind to be more curious, put it into a crucible, and keep it over the fire till it be red hot.

Ivory alſo muſt be burnt to make black, thus: Fill two crucibles with ſhavings of ivory, then clap their two mouths together, and bind them faſt with an iron wire, and lute the joints cloſe with clay, ſalt, and horſe-dung, well beaten together; then ſet it over the fire, covering it all over with coals: let it remain in the fire till you are ſure that the matter encloſed is thoroughly red hot: then take it out of the fire; but do not open the crucibles till they are perfectly cold; for were they opened while hot, the matter would turn to aſhes; and ſo it will be, if the joints are not luted cloſe.

BURNISHER, a round poliſhed piece of ſteel ſerving to ſmooth and give a luſtre to metals.

Of theſe there are different kinds of different figures, ſtraight, crooked, &c. Half burniſhers are uſed to ſolder ſilver, as well as to give a luſtre.

Burniſhers for gold and ſilver are commonly made of a dog's or wolf's tooth, ſet in the end of an iron or wooden handle. Of late, agates and pebbles have been introduced, which many prefer to the dog's tooth.

The burniſhers uſed by engravers in copper, uſually ſerve with one end to burniſh, and with the other to ſcrape.

BURNISHING, the art of ſmoothing or poliſhing a metaline body, by a briſk rubbing of it with a burniſher.

Book-binders burniſh the edges of their books, by rubbing them with a dog's tooth.

BURNLEY, a town of Lancaſhire in England, ſituated in W. Long. 2. 5. N. Lat. 51. 38.

BURNS, Robert, was a native of Ayrſhire, one of the weſtern counties of Scotland. He was the ſon of humble parents; and his father paſſed through life in the condition of a hired labourer, or of a ſmall farmer. Even in this ſituation, however, it was not hard for him to ſend his children to the pariſh ſchool, to receive the ordinary inſtruction in reading, writing, arithmetic, and the principles of religion. By this courſe of education young Robert profited to a degree that might have encouraged his friends to deſtine him to one of the liberal profeſſions, had not his father's poverty made it neceſſary to remove him from ſchool, as ſoon as he had grown up, to earn for himſelf the means of ſupport as a hired ploughboy or ſhepherd.

The expence of education in the pariſh-ſchools of Scotland is ſo ſmall, that hardly any parents who are able to labour want the means of giving to their children at leaſt ſuch education as young Burns received. From the ſpring labours of a ploughboy, from the ſummer employment of a ſhepherd, the peaſant-youth often returns for a few months, eagerly to purſue his education at the pariſh-ſchool.

It was ſo with Burns; he returned from labour to learning, and from learning went again to labour, till his mind began to open to the charms of taſte and knowledge; till he began to feel a paſſion for books, and for the ſubjects of books, which was to give a colour to the whole thread of his future life. On nature he ſoon began to gaze with new diſcernment and with new enthuſiaſm: his mind's eye opened to perceive affecting beauty and ſublimity, where, by the mere groſs peaſant, there was nought to be ſeen but water, earth, and ſky—but animals, plants, and ſoil.

What might perhaps firſt contribute to diſpoſe his mind to poetical efforts, is one particular in the devotional piety of the Scotiſh peaſantry. It is ſtill common for them to make their children get by heart the Pſalms of David, in the verſion of homely rhymes which is uſed in their churches. In the morning and in the evening of every day, or at leaſt on the evening of every Saturday and Sunday, theſe Pſalms are ſung in ſolemn family-devotion, a chapter of the Bible is read, and extemporary prayer is fervently uttered. The whole books of the ſacred Scriptures are thus continually in the hands of almoſt every peaſant. And it is impoſſible that there ſhould not be occaſionally ſome ſouls among them, awakened to the divine emotions of genius by that rich aſſemblage which thoſe books preſent, of almoſt all that is intereſting in incidents, or pictureſque in imagery, or affectingly ſublime or tender in ſentiments and character. It is impoſſible that thoſe rude rhymes, and the ſimple artleſs muſic with which they are accompanied, ſhould not occaſionally excite ſome ear to a fond perception of the melody of verſe. That Burns had felt theſe impulſes, will appear undeniably certain to whoever ſhall carefully peruſe his *Cot-*

tar's Saturday's Night; or ſhall remark, with nice obſervation, the various fragments of Scripture ſentiment, of Scripture imagery, of Scripture language, which are ſcattered throughout his works.

Still more intereſting to the young peaſantry are thoſe ancient ballads of love and war, of which a great number are, in the ſouth of Scotland, yet popularly known, and often ſung by the ruſtic maid or matron at her ſpinning-wheel. They are liſtened to with raviſhed ears by old and young. Their rude melody; that mingled curioſity and awe which are naturally excited by the very idea of their antiquity; the exquiſitely tender and natural complaints ſometimes poured forth in them; the gallant deeds of knightly heroiſm, which they ſometimes celebrate; their wild tales of demons, ghoſts, and fairies, in whoſe exiſtence ſuperſtition alone has believed; the manners which they repreſent; the obſelete, yet pictureſque and expreſſive, language in which they are often clothed—give them wonderful power to tranſport every imagination, and to agitate every heart. To the ſoul of Burns they were like a happy breeze touching the wires of an Æolian harp, and calling forth the moſt raviſhing melody.

Beſide all this, the Gentle Shepherd, and the other poems of Allan Ramſay, have long been highly popular in Scotland. They fell early into the hands of Burns; and while the fond applauſe which they received drew his emulation, they preſented to him likewiſe treaſures of phraſeology and models of verſification. He got acquainted at the ſame time with the poetry of Robert Ferguſon, written chiefly in the Scotiſh dialect, and exhibiting many ſpecimens of uncommon poetical excellence. The Seaſons of Thomſon too, the Grave of Blair, the far-famed Elegy of Gray, the Paradiſe Loſt of Milton, perhaps the Minſtrel of Beattie, were ſo commonly read, even among thoſe with whom Burns would naturally aſſociate, that poetical curioſity, although even leſs ardent than his, could in ſuch circumſtances have little difficulty in procuring them.

With ſuch means to give his imagination a poetical bias, and to favour the culture of his taſte and genius, Burns gradually became a poet. He was not, however, one of thoſe forward children who, from a miſtaken impulſe, begin prematurely to write and to rhyme, and hence never attain to excellence. Converſing familiarly for a long while with the works of thoſe poets who were known to him; contemplating the aſpect of nature in a diſtrict which exhibits an uncommon aſſemblage of the beautiful and the ruggedly grand, of the cultivated and the wild; looking upon human life with an eye quick and keen, to remark as well the ſtronger and leading, as the nicer and ſubordinate, features of character; to diſcriminate the generous, the honourable, the manly in conduct, from the ridiculous, the baſe, and the mean—he was diſtinguiſhed among his fellows for extraordinary intelligence, good ſenſe, and penetration, long before others, or perhaps even himſelf, ſuſpected him to be capable of writing verſes. His mind was mature, and well ſtored with ſuch knowledge as lay within his ſearch: he had made himſelf maſter of powers of language, ſuperior to thoſe of almoſt any former writer in the Scotiſh dialect, before he conceived the idea of ſurpaſſing Ramſay and Ferguſon.

Hitherto he had converſed intimately only with peaſants on his own level; but having got admiſſion into the fraternity of free-maſons, he had the fortune, whether good or bad, to attract in the lodges the notice of gentlemen better qualified than his more youthful companions to call forth the powers of his mind, and to ſhow him that he was indeed a poet. A maſonic ſong, a ſatirical epigram, a rhyming epiſtle to a friend, attempted with ſucceſs, taught him to know his own powers, and gave him confidence to try taſks more arduous, and which ſhould command ſtill higher burſts of applauſe.

The annual celebration of the ſacrament of the Lord's Supper, in the rural pariſhes of Scotland, has much in it of thoſe old popiſh feſtivals, in which ſuperſtition, traffic, and amuſement, uſed to be ſtrangely intermingled. Burns ſaw, and ſeized in it one of the happieſt of all ſubjects, to afford ſcope for the diſplay of that ſtrong and piercing ſagacity by which he could almoſt intuitively diſtinguiſh the reaſonable from the abſurd, and the becoming from the ridiculous; of that pictureſque power of fancy, which enabled him to repreſent ſcenes, and perſons, and groupes, and looks, attitudes, and geſtures, in a manner almoſt as lively and impreſſive, even in words, as if all the artifices and energies of the pencil had been employed; of that knowledge which he had neceſſarily acquired of the manners, paſſions, and prejudices of the ruſtics around him, of whatever was ridiculous, no leſs than of whatever was affectingly beautiful, in rural life.

A thouſand prejudices of Popiſh, and perhaps too of ruder Pagan ſuperſtition, have from time immemorial been connected in the minds of the Scotiſh peaſantry, with the annual recurrence of the Eve of the Feſtival of all the Saints, or Halloween. Theſe were all intimately known to Burns, and had made a powerful impreſſion upon his imagination and feelings. He choſe them for the ſubject of a poem, and produced a piece which is almoſt to frenzy the delight of thoſe who are beſt acquainted with its ſubject; and which will not fail to preſerve the memory of the prejudices and uſages which it deſcribes, when they ſhall perhaps have ceaſed to give one merry evening in the year to the cottage fire-ſide.

The ſimple joys, the honeſt love, the ſincere friendſhip, the ardent devotion of the cottage; whatever in the more ſolemn part of the ruſtic's life is humble and artleſs, without being mean or unſeemly—or tender and dignified, without aſpiring to ſtilted grandeur, or to unnatural buſkined pathos, had deeply impreſſed the imagination of the riſing poet; had, in ſome ſort, wrought itſelf into the very texture of the fibres of his ſoul. He tried to expreſs in verſe what he moſt tenderly felt, what he moſt enthuſiaſtically imagined; and produced the *Cottar's Saturday's Night*.

Theſe pieces, the true effuſion of genius, informed by reading and obſervation, and prompted by its own native ardour, as well as by friendly applauſe, were ſoon handed about amongſt the moſt diſcerning of Burns's acquaintance; and were by every new reader peruſed and reperuſed, with an eagerneſs of delight and approbation which would not ſuffer their author long to withhold them from the preſs. A ſubſcription was propoſed; was earneſtly promoted by ſome gentlemen, who were glad to intereſt themſelves in behalf of ſuch ſignal poetical merit; was ſoon crowded with the names of a conſiderable number of the inhabitants of Ayrſhire, who in the proffered purchaſe ſought not leſs to gratify their own paſſion for Scotiſh poeſy, than to encourage the wonderful ploughman. At Kilmarnock were the poems of Burns for the firſt time printed. The whole edition was quickly diſtributed over the country.

It is hardly poſſible to expreſs with what eager admiration and delight they were everywhere received.—They eminently poſſeſſed all thoſe qualities which the moſt invariably contribute to render any literary work quickly and permanently popular. They were written in a phraſeology, of which all the powers were univerſally felt; and which being at once antique, familiar, and now rarely written, was hence fitted to ſerve all the dignified and pictureſque uſes of poetry, without making it unintelligible. The imagery, the ſentiments, were at once faithfully natural, and irreſiſtibly impreſſive and intereſting. Thoſe topics of ſatire and ſcandal in which the ruſtic delights; that humorous imitation of character, and that witty aſſociation of ideas familiar and ſtriking, yet not naturally allied to one another, which has force to ſhake his ſides with laughter; thoſe fancies of ſuperſtition, at which he ſtill wonders and trembles; thoſe affecting ſentiments and images of true religion, which are at once dear and awful to his heart, were all repreſented by Burns with all a poet's magic power. Old and young, high and low, grave and gay, learned or ignorant, all were alike delighted, agitated, tranſported.

In the mean time, ſome few copies of theſe faſcinating poems found their way to Edinburgh; and having been read to Dr Blacklock, they obtained his warmeſt approbation. In the beginning of the winter 1786-7 Burns went to Edinburgh, where he was received by Dr Blacklock with the moſt flattering kindneſs, and introduced to every man of generoſity and taſte among that good man's friends. Multitudes now vied with each other in patronizing the ruſtic poet. Thoſe who poſſeſſed at once true taſte and ardent philanthropy were ſoon earneſtly united in his praiſe: they who were diſpoſed to favour any good thing belonging to Scotland, purely becauſe it was Scotiſh, gladly joined the cry; thoſe who had hearts and underſtanding to be charmed, without knowing why, when they ſaw their native cuſtoms, manners, and language, made the ſubjects and the materials of poeſy, could not ſuppreſs that voice of feeling which ſtruggled to declare itſelf for Burns: for the diſſipated, the licentious, the malignant wits, and the freethinkers, he was ſo unfortunate as to have ſatire, and obſcenity, and ridicule of things ſacred, ſufficient to captivate their fancies; even for the pious he had paſſages in which the inſpired language of devotion might ſeem to come mended from his pen.

Thus did Burns, ere he had been many weeks in Edinburgh, find himſelf the object of univerſal curioſity, favour, admiration, and fondneſs. He was ſought after, courted with attentions the moſt reſpectful and aſſiduous, feaſted, flattered, careſſed, treated by all ranks as the firſt boaſt of his country, whom it was ſcarcely poſſible to honour and reward to a degree equal to his merits. In compariſon with the general favour which now promiſed to more than crown his moſt ſanguine hopes, it could hardly be called praiſe at all which he had obtained in Ayrſhire.

In this poſture of our poet's affairs a new edition of his poems was earneſtly called for. He ſold the copy-right for 100l.; but his friends at the ſame time ſuggeſted, and actively promoted, a ſubſcription for an edition, to be publiſhed for the benefit of the author, ere the bookſeller's right ſhould commence. Thoſe gentleman who had formerly entertained the public of Edinburgh with the periodical publication of the papers of the *Mirror*, having again combined their talents in producing the *Lounger*, were at this time about to conclude this laſt ſeries of papers; yet before the Lounger relinquiſhed his pen, he dedicated a number to a commendatory criticiſm of the poems of the Ayrſhire bard.

The ſubſcription-papers were rapidly filled; and it was ſuppoſed that the poet might derive from the ſubſcription and the ſale of his copy-right a clear profit of at leaſt 700l.

The converſation of even the moſt eminent authors is often found to be ſo unequal to the fame of their writings, that he who reads with admiration can liſten with none but ſentiments of the moſt profound contempt. But the converſation of Burns was, in compariſon with the formal and exterior circumſtances of his education, perhaps even more wonderful than his poetry. He affected no ſoft air or graceful motions of politeneſs, which might have ill accorded with the ruſtic plainneſs of his native manners. Conſcious ſuperiority of mind taught him to aſſociate with the great, the learned, and the gay, without being overawed into any ſuch baſhfulneſs as might have made him confuſed in thought, or heſitating in elocution. He poſſeſſed withal an extraordinary ſhare of plain common ſenſe or mother-wit, which prevented him from obtruding upon perſons, of whatever rank, with whom he was admitted to converſe, any of thoſe effuſions of vanity, envy, or ſelf-conceit, in which authors are exceedingly apt to indulge, who have lived remote from the general practice of life, and whoſe minds have been almoſt excluſively confined to contemplate their own ſtudies and their own works. In converſation he diſplayed a ſort of intuitive quickneſs and rectitude of judgment upon every ſubject that aroſe. The ſenſibility of his heart, and the vivacity of his fancy, gave a rich colouring to whatever reaſoning he was diſpoſed to advance; and his language in converſation was not at all leſs happy than in his writings. For theſe reaſons, thoſe who had met and converſed with him once, were pleaſed to meet and to converſe with him again and again.

For ſome time he converſed only with the virtuous, the learned, and the wiſe; and the purity of his morals remained uncontaminated. But, alas! he fell, as others have fallen in ſimilar circumſtances. He ſuffered himſelf to be ſurrounded by a race of miſerable beings, who were proud to tell that they had been in company with Burns, and had ſeen Burns as looſe and as fooliſh as themſelves. He was not yet irrecoverably loſt to temperance and moderation; but he was already almoſt too much captivated with their wanton rivals, to be ever more won back to a faithful attachment to their more ſober charms. He now alſo began to contract ſomething of new arrogance in converſation. Accuſtomed to be among his favourite aſſociates what is vulgarly but expreſſively called *the cock of the company*, he could ſcarcely refrain from indulging in ſimilar freedom and dictatorial deciſion of talk, even in the preſence of perſons who could leſs patiently endure his preſumption.

The ſubſcription edition of his poems, in the mean time, appeared; and although not enlarged beyond that which came from the Kilmarnock preſs by any new pieces of eminent merit, did not fail to give entire ſatisfaction to the ſubſcribers. He was now to cloſe accounts with his bookſeller and his printer, to retire to the country with his profits in his pocket, and to fix upon a plan for his future life. He talked loudly of independence of ſpirit, and ſimplicity of manners, and boaſted his reſolution to return to the plough; yet ſtill he lingered in Edinburgh, week after week, and month after month, perhaps expecting that one or other of his noble patrons might procure him ſome permanent and competent annual income, which ſhould ſet him above all neceſſity of future exertions to earn for himſelf the means of ſubſiſtence; perhaps unconſciouſly reluctant to quit the pleaſures of that voluptuous town-life to which he had for ſome time too willingly accuſtomed himſelf. An accidental diſlocation or fracture of an arm or a leg confining him for ſome weeks to his apartment, left him during this time leiſure for ſerious reflection; and he determined to retire from the town without longer delay. None of all his patrons interpoſed to divert him from his purpoſe of returning to the plough, by the offer of any ſmall penſion, or any ſinecure place of moderate emolument, ſuch as might have given him competence without withdrawing him from his poetical ſtudies. It ſeemed to be forgotten that a ploughman thus exalted into a man of letters was unfitted for his former toils, without being regularly qualified to enter the career of any new profeſſion; and that it became incumbent upon thoſe patrons who had called him from the plough, not merely to make him their companion in the hour of riot, not ſimply to fill his purſe with gold for a few tranſient expences, but to ſecure him, as far as was poſſible, from being ever overwhelmed in diſtreſs in conſequence of the favour which they had ſhown him, and of the habits of life into which they had ſeduced him. Perhaps indeed the ſame deluſion of fancy betrayed both Burns and his patrons into the miſtaken idea, that, after all which had paſſed, it was ſtill poſſible for him to return in cheerful content to the homely joys and ſimple toils of undiſſipated rural life.

In this temper of Burns's mind, in this ſtate of his fortune, a farm and the exciſe were the objects upon which his choice ultimately fixed for future employment and ſupport. By the ſurgeon who attended him during his illneſs, he was recommended with effect to the commiſſioners of exciſe; and Patrick Miller, Eſq. of Dalſwinton, deceived, like Burns himſelf and Burns's other friends, into an idea that the poet and exciſeman might yet be reſpectable and happy as a farmer, generouſly propoſed to eſtabliſh him in a farm, upon conditions of leaſe which prudence and induſtry might eaſily render exceedingly advantageous. Burns eagerly accepted the offers of this benevolent patron. Two of the poet's friends from Ayrſhire were invited to ſurvey that farm in Dumfriesſhire which Mr Millar offered. A leaſe was granted to the poetical farmer at that annual rent which his own friends declared that the due cultivation of his farm might eaſily enable him to pay. What yet remained of the profits of his publication was laid out in the purchaſe of farm ſtock; and Mr Millar might, for ſome ſhort time, pleaſe himſelf with the perſuaſion that he had approved himſelf the liberal patron of genius; had acquired a good tenant upon his eſtate; and had placed a deſerving man in the very ſituation in which alone he himſelf deſired to be placed, in order to be happy to his wiſhes.

Burns, with his Jane, whom he now married, took up their reſidence upon his farm. The neighbouring farmers and gentlemen, pleaſed to obtain for an inmate among them the poet by whoſe works they had been delighted, kindly ſought his company, and invited him to their houſes. He found an inexpreſſible charm in ſitting down beſide his wife, at his own fireſide; in wandering over his own grounds; in once more putting his hand to the ſpade and the plough; in forming his incloſures, and managing his cattle. For ſome months he felt almoſt all that felicity which fancy had taught him to expect in his new ſituation. He had been for a time idle; but his muſcles were not yet unbraced for rural toil. He now ſeemed to find a joy in being the huſband of the miſtreſs of his affections, in ſeeing himſelf the father of her children, ſuch as might promiſe to attach him for ever to that modeſt, humble, and domeſtic life, in which alone he could hope to be permanently happy. Even his engagements in the ſervice of the exciſe did not, at the very firſt, threaten neceſſarily to debaſe him by aſſociation with the mean, the groſs, and the profligate, to contaminate the poet, or to ruin the farmer.

But it could not be: it was not poſſible for Burns now to aſſume that ſoberneſs of fancy and paſſions, that ſedateneſs of feeling, thoſe habits of earneſt attention to groſs and vulgar cares, without which ſucceſs in his new ſituation was not to be expected. A thouſand difficulties were to be encountered and overcome, much money was to be expended, much weary toil was to be exerciſed, before his farm could be brought into a ſtate of cultivation, in which its produce might enrich the occupier. This was not a proſpect encouraging to a man who had never loved labour, and who was at this time certainly not at all diſpoſed to enter into agriculture with the enthuſiaſm of a projector. The buſineſs of the exciſe too, as he began to be more and more employed in it, diſtracted his mind from the care of his farm, led him into groſs and vulgar ſociety, and expoſed him to many unavoidable temptations to drunken exceſs, ſuch as he had no longer ſufficient fortitude to reſiſt. Amidſt the anxieties, diſtractions, and ſeducements which thus aroſe to him, home became inſenſibly leſs and leſs pleaſing; even the endearments of his Jane's affection began to loſe their hold on his heart; he became every day leſs and leſs unwilling to forget in riot thoſe gathering ſorrows which he knew not to ſubdue.

Mr Millar and ſome others of his friends would gladly have exerted an influence over his mind which might have preſerved him in this ſituation of his affairs, equally from deſpondency and from diſſipation; but Burns's temper ſpurned all controul from his ſuperiors in fortune. He reſented, as an arrogant encroachment upon his independence, that tenor of conduct by which Mr Millar wiſhed to turn him from diſſolute conviviality, to that ſteady attention to the buſineſs of his farm, without which it was impoſſible to thrive in it.

His croſſes and diſappointments drove him every day more and more into diſſipation; and his diſſipation tended to enhance whatever was diſagreeable and perplexing in the ſtate of his affairs. He ſunk, by degrees, into the boon companion of mere exciſemen; and almoſt every drunken fellow, who was willing to ſpend his money laviſhly in the alehouſe, could eaſily command the company of Burns. The care of his farm was thus neglected; waſte and loſſes wholly conſumed his little capital; he reſigned his leaſe into the hands of his landlord; and retired, with his family, to the town of Dumfries, determining to depend entirely for the means of future ſupport upon his income as an exciſe-officer.

Yet during this unfortunate period of his life, which paſſed between his departure from Edinburgh to ſettle in Dumfriesſhire, and his leaving the country in order to take up his reſidence in the town of Dumfries, the energy and activity of his intellectual powers appeared not to have been at all impaired. In a collection of Scotiſh ſongs, which were publiſhed (the words with the muſic) by Mr Johnſon, engraver in Edinburgh, in 4 vols 8vo, Burns in many inſtances, accommodated new verſes to the old tunes with admirable felicity and ſkill. He aſſiſted in the temporary inſtitution of a ſmall ſubſcription library, for the uſe of a number of the well-diſpoſed peaſants in his neighbourhood. He readily aided, and by his knowledge of genuine Scotiſh phraſeology and manners greatly enlightened, the antiquarian reſearches of the late ingenious Captain Groſe. He ſtill carried on an epiſtolary correſpondence, ſometimes gay, ſportive, humorous, but always enlivened by bright flaſhes of genius, with a number of his old friends, and on a very wide diverſity of topics. At times, as it ſhould ſeem from his writings of this period, he reflected, with inexpreſſible heart-bitterneſs, on the high hopes from which he had fallen; on the errors of moral conduct into which he had been hurried by the ardour of his ſoul, and in ſome meaſure by the very generoſity of his nature; on the diſgrace and wretchedneſs into which he ſaw himſelf rapidly ſinking; on the ſorrow with which his miſconduct oppreſſed the heart of his Jane; on the want and deſtitute miſery in which it ſeemed probable that he muſt leave her and their infants; nor amidſt theſe agonizing reflections did he fail to look, with an indignation half invidious, half contemptuous, on thoſe who, with moral habits not more excellent than his, with powers of intellect far inferior, yet baſked in the ſunſhine of fortune, and were loaded with the wealth and honours of the world, while his follies could not obtain pardon, nor his wants an honourable ſupply. His wit became from this time more gloomily ſarcaſtic; and his converſation and writings began to aſſume ſomething of a tone of miſanthropical malignity, by which they had not been before, in any eminent degree, diſtinguiſhed. But with all theſe failings, he was ſtill that exalted mind which had raiſed itſelf above the depreſſion of its original condition: with all the energy of the lion, pawing to ſet free his hinder limbs from the yet encumbering earth, he ſtill appeared *not leſs than archangel ruined!*

His morals were not mended by his removal from the country. In Dumfries his diſſipation became ſtill more deeply habitual; he was here more expoſed than in the country to be ſolicited to ſhare the riot of the diſſolute and the idle: fooliſh young men flocked eagerly about him, and from time to time preſſed him to drink with them, that they might enjoy his wicked wit. The Caledonian Club, too, and the Dumfriesſhire and Galloway Hunt, had occaſional meetings in Dumfries after Burns went to reſide there, and the poet was of courſe invited to ſhare their conviviality, and heſitated not to accept the invitation.

In the intervals between his different fits of intemperance, he ſuffered ſtill the keeneſt anguiſh of remorſe, and horribly afflictive foreſight. His Jane ſtill behaved with a degree of maternal and conjugal tenderneſs and prudence, which made him feel more bitterly the evil of his miſconduct, although they could not reclaim him. At laſt crippled, emaciated, having the very power of animation waſted by diſeaſe, quite broken-hearted by the ſenſe of his errors, and of the hopeleſs miſeries in which he ſaw himſelf and his family depreſſed; with his ſoul ſtill tremblingly alive to the ſenſe of ſhame, and to the love of virtue; yet even in the laſt feebleneſs, and amid the laſt agonies of expiring life, yielding readily to any temptation that offered the ſemblance of intemperate enjoyment, he died at Dumfries, in the ſummer of 1796, while he was yet three or four years under the age of 40, furniſhing a melancholy proof of the danger of *ſuddenly* elevating even the greateſt mind above its original level.

After his death it quickly appeared that his failings had not effaced from the minds of his more reſpectable acquaintance either the regard which had once been won by his ſocial qualities, or the reverence due to his intellectual talents. The circumſtances of want in which he left his family were noticed by the gentlemen of Dumfries with earneſt commiſeration. His funeral was celebrated by the care of his friends with a decent ſolemnity, and with a numerous attendance of mourners, ſufficiently honourable to his memory. Several copies of verſes were inſerted in different newſpapers upon the occaſion of his death. A contribution, by ſubſcription, was propoſed, for the purpoſe of raiſing a ſmall fund, for the decent ſupport of his widow, and the education of his infant children.

From the preceding detail of the particulars of this poet's life, the reader will naturally and juſtly infer him to have been an honeſt, proud, warm-hearted man; of high paſſions and ſound underſtanding, and a vigorous and excurſive imagination. He was never known to deſcend to any act of deliberate meanneſs. In Dumfries he retained many reſpectable friends, even to the laſt. It may be doubted whether he has not, by his writings, exerciſed a greater power over the minds of men, and, by conſequence, on their conduct, upon their happineſs and miſery, and upon the general ſyſtem of life, than has been exerciſed by any half dozen of the moſt eminent ſtateſmen of the preſent age. The power of the ſtateſman is but ſhadowy, ſo far as it acts upon externals alone: the power of the writer of genius ſubdues the heart and the underſtanding, and having thus made the very ſpring of action its own, through them moulds almoſt all life and nature at its pleaſure. Burns has not failed to command one remarkable ſort of homage, ſuch as is never paid but to great original genius: a crowd of poetaſters ſtarted up to imitate him, by writing verſes as he had done, in the Scotiſh dialect; but, *O imitatores! ſervum pecus!* To perſons to whom the Scotiſh dialect, and the cuſtoms and manners of rural life in Scotland, have no charm, too much may appear to have been ſaid about Burns; by thoſe who paſſionately admire him, a great deal more, perhaps, was expected.

A complete edition of his works in 4 vols 8vo, was publiſhed under the ſuperintendence of Dr Currie of Liverpool, who drew up an elaborate and valuable account of the life of the poet, which is prefixed. From the profits of this edition his widow and family have received a handſome ſum. The following letter from Burns to the late Dr Moore, gives ſo intereſting an account of the tranſactions of his early years, and affords ſo good a ſpecimen of vigour of thought and force of expreſſion in his proſe compoſition, that we hope it will prove acceptable to our readers.

“ *Mauchline*, Auguſt 2. 1787.—Sir, For ſome months paſt I have been rambling up and down the country, but I am now confined with ſome lingering complaints, originating, as I take it, in the ſtomach. To divert my ſpirits a little in this miſerable fog of *ennui*. I have taken a whim to give you a hiſtory of myſelf. My name has made ſome little noiſe in this country; you have done me the honour to intereſt yourſelf very warmly in my behalf; and I think a faithful account of what character of a man I am, and how I came by that character, may perhaps amuſe you in an idle moment. I will give you an honeſt narrative, though I know it will be often at my own expence; for I aſſure you, Sir, I have, like Solomon, whoſe character, excepting in the trifling affair of wiſdom, I ſometimes think I reſemble, I have, I ſay, like him turned my eyes to behold madneſs and folly, and like him too, frequently ſhaken hands with their intoxicating friendſhip. * * * After you have peruſed theſe pages, ſhould you think them trifling and impertinent, I only beg leave to tell you, that the poor author wrote them under ſome twitching qualms of conſcience, ariſing from a ſuſpicion that he was doing what he ought not to do; a predicament he has more than once been in before.

“ I have not the moſt diſtant pretenſions to aſſume that character which the pye-coated guardians of eſcutcheons call, a gentleman. When at Edinburgh laſt winter, I got acquainted in the heralds office, and looking through that granary of honours, I there found almoſt every name of the kingdom; but for me,

——My ancient but ignoble blood
Has crept thro' ſcoundrels ever ſince the flood.

Gules, purpure, argent, &c. quite diſowned me.

“ My father was of the north of Scotland, the ſon of a farmer, and was thrown by early miſfortunes on the world at large; where, after many years wanderings and ſojournings, he picked up a pretty large quantity of obſervation and experience, to which I am indebted for moſt of my little pretenſions to wiſdom.—I have met with few who underſtood men, their manners, and their ways, equal to him; but ſtubborn ungainly integrity, and headlong ungovernable iraſcibility, are diſqualifying circumſtances; conſequently I was born a very poor man's ſon. For the firſt ſix or ſeven years of my life, my father was a gardener to a worthy gentleman of a ſmall eſtate in the neighbourhood of Ayr. Had he continued in that ſtation, I muſt have marched off to be one of the little underlings about a farm-houſe; but it was his deareſt wiſh and prayer to have it in his power to keep his children under his own eye, till they could diſcern between good and evil; ſo with the aſſiſtance of his generous maſter, my father ventured on a ſmall farm on his eſtate. At theſe years I was by no means a favourite with any body. I was a good deal noted for a retentive memory, a ſtubborn ſturdy ſomething in my diſpoſition, and an enthuſiaſtic ideot piety. I ſay ideot piety, becauſe I was then but a child. Though it coſt the ſchoolmaſter ſome thraſhings, I made an excellent Engliſh ſcholar; and by the time I was 10 or 12 years of age, I was a critic in ſubſtantives, verbs, and particles. In my infant and boyiſh days too, I owed much to an old woman who reſided in the family, remarkable for her ignorance, credulity, and ſuperſtition. She had, I ſuppoſe, the largeſt collection in the country, of tales and ſongs concerning devils, ghoſts, fairies, brownies, witches, warlocks, ſpunkies, kelpies, elf-candles, dead-lights, wraiths, apparitions, cantraips, giants, inchanted towers, dragons, and other trumpery. This cultivated the latent ſeeds of poetry; but had ſo ſtrong an effect on my imagination, that to this hour, in my nocturnal rambles, I ſometimes keep a ſharp look-out in ſuſpicious places; and though nobody can be more ſceptical than I am in ſuch matters, yet it often takes an effort of philoſophy to ſhake off theſe idle terrors. The earlieſt compoſition that I recollect taking pleaſure in, was the Viſion of Mirza, and a hymn of Addiſon's, beginning, ‘ How are thy ſervants bleſt, O Lord !’ I particularly remember one half-ſtanza which was muſic to my boyiſh ear—

For though on dreadful whirls we hung
High on the broken wave.—

I met with theſe pieces in Maſon's Engliſh Collection, one of my ſchool-books. The two firſt books I ever read in private, and which gave me more pleaſure than any two books I ever read ſince, were, The Life of Hannibal, and The Hiſtory of Sir William Wallace. Hannibal gave my young ideas ſuch a turn, that I uſed to ſtrut in raptures up and down after the recruiting drum and bag-pipe, and wiſh myſelf tall enough to be a ſoldier; while the ſtory of Wallace poured a Scotiſh prejudice into my veins, which will boil along there, till the flood-gates of life ſhut in eternal reſt.

“ Polemical divinity about this time was putting the country half mad, and I, ambitious of ſhining in converſation parties on Sundays between ſermons, at funerals, &c. uſed a few years afterwards to puzzle Calviniſm with ſo much heat and indiſcretion, that I raiſed a hue and cry of hereſy againſt me, which has not ceaſed to this hour.

“ My vicinity to Ayr was of ſome advantage to me. My ſocial diſpoſition, when not checked by ſome modifications of ſpited pride, was, like our catechiſm definition of infinitude, without bounds or limits. I formed ſeveral connexions with other younkers who poſſeſſed ſuperior advantages; the youngling actors who were buſy in the rehearſal of parts in which they were ſhortly to appear on the ſtage of life, where, alas! I was deſtined to drudge behind the ſcenes. It is not commonly at this green age, that our young gentry have a juſt ſenſe of the immenſe diſtance between them and their ragged play-fellows. It takes a few daſhes into the world, to give the young great man that proper, decent, unnoticing diſregard for the poor, inſignificant, ſtupid devils, the mechanics and peaſantry around him, who were perhaps born in the ſame village. My young ſuperiors never inſulted the *clouterly* appearance of my plough-boy carcaſe, the two extremes of which were often expoſed to all the inclemencies of all the ſeaſons. They would give me ſtray volumes of books; among them, even then, I could pick up ſome obſervations, and one, whoſe heart I am ſure not even the Munny Begum ſcenes have tainted, helped me to a little French. Parting with theſe my young friends and benefactors, as they occaſionally went off for the Eaſt or Weſt Indies, was often to me a ſore affliction, but I was ſoon called to more ſerious evils, My father's generous maſter died; the farm proved a ruinous bargain; and to clench the miſfortune, we fell into the hands of a factor, who ſat for the picture I have drawn of one in my tale of Twa Dogs. My father was advanced in life when he married; I was the eldeſt of ſeven children, and he, worn out by early hardſhips, was unfit for labour. My father's ſpirit was ſoon irritated, but not eaſily broken. There was a freedom in his leaſe in two years more, and to weather theſe two years, we retrenched our expences. We lived very poorly: I was a dexterous ploughman for my age; and the next oldeſt to me was a brother (Gilbert) who could drive the plough very well, and help me to thraſh the corn. A novel-writer might perhaps have viewed theſe ſcenes with ſome ſatisfaction, but ſo did not I; my indignation yet boils at the recollection of the f——l factor's inſolent threatening letters, which uſed to ſet us all in tears.

“ This kind of life—the cheerleſs gloom of a hermit, with the unceaſing moil of a galley-ſlave, brought me to my 16th year; a little before which period I firſt committed. the ſin of rhyme. You know our country cuſtom of coupling a man and woman together as partners in the labours of harveſt. In my 15th autumn, my partner was a bewitching creature, a year younger than myſelf. My ſcarcity of Engliſh denies me the power of doing her juſtice in that language, but you know the Scotiſh idiom; ſhe was a bonnie, ſweet, ſonſie laſs. In ſhort, ſhe altogether, unwittingly to herſelf, initiated me in that delicious paſſion, which, in ſpite of acid diſappointment, gin-horſe prudence, and book-worm philoſophy, I hold to be the firſt of human joys, our deareſt bleſſing here below! How ſhe caught the contagion I connot tell; you medical people talk much of infection from breathing the ſame air, the touch, &c. but I never expreſsly ſaid I loved her.—Indeed I did not know myſelf why I liked ſo much to loiter behind with her, when returning in the evening from our labours; why the tones of her voice made my heart-ſtrings thrill like an Æolian harp; and particularly why my pulſe beat ſuch a furious ratan when I looked and fingered over her little hand to pick out the cruel nettle-ſtings and thiſtles. Among her other love-inſpiring qualities, ſhe ſung ſweetly; and it was her favourite reel to which I attempted giving an embodied vehicle in rhyme. I was not ſo preſumptuous as to imagine that I could make verſes like printed ones, compoſed by men who had Greek and Latin; but my girl ſung a ſong which was ſaid to be compoſed by a ſmall country laird's ſon, on one of his father's maids, with whom he was in love; and I ſaw no reaſon why I might not rhyme as well as he; for excepting that he could ſmear ſheep, and caſt peats, his father living in the moorlands, he had no more ſcholar-craft than myſelf.

“ Thus with me began love and poetry; which at times have been my only, and, till within the laſt 12 months, have been my higheſt enjoyment. My father ſtruggled on till he reached the freedom in his leaſe, when he entered on a larger farm, about ten miles farther in the country. The nature of the bargain he made was ſuch as to throw a little ready money into his hands at the commencement of his leaſe, otherwiſe the affair would have been impracticable. For four years we lived comfortably here; but a difference commencing between him and his landlord as to terms, after three years toſſing and whirling in the vortex of litigation, my father was juſt ſaved from the horrors of a jail, by a conſumption, which, after two years promiſes, kindly ſtepped in, and carried him away, to “ where the wicked ceaſe from troubling, and where the weary are at reſt!”

“ It is during the time that we lived on this farm, that my little ſtory is moſt eventful. I was, at the beginning of this period, perhaps the moſt ungainly awkward boy in the pariſh—no ſolitaire was leſs acquainted with the ways of the world. What I knew of ancient ſtory was gathered from Salmon's and Guthrie's geographical grammars; and the ideas I had formed of modern manners, of literature, and criticiſm, I got from the Spectator. Theſe, with Pope's Works, ſome plays of Shakeſpeare, Tull and Dickſon on Agriculture, the Pantheon, Locke's Eſſay on the Human Underſtanding, Stackhouſe's Hiſtory of the Bible, Juſtice's Britiſh Gardener's Directory, Bayle's Lectures, Allan Ramſay's Works, Taylor's Scripture Doctrine of Original Sin, a Select Collection of Engliſh Songs, and Hervey's Meditations, had formed the whole of my reading. The collection of ſongs was my *vade mecum*. I pored over them driving my cart, or walking to labour, ſong by ſong, verſe by verſe; carefully noting the true tender, or ſublime, from affectation and fuſtian. I am convinced I owe to this practice much of my critic-craft, ſuch as it is.” (*Month. Mag. and Currie's Life of Burns.*)

BURNTISLAND. See BRUNTISLAND.

BURNTWOOD, a town of Eſſex in England, ſituated on a hill, in E. Long. 0. 25. N. Lat. 51. 38.

BURR, the round knob of a horn next a deer's head.

BURRE, BOUREE, or *Boree*, a kind of dance compoſed of three ſteps joined together in two motions, begun with a crotchet riſing. The firſt couplet contains twice four meaſures, the ſecond twice eight. It conſiſts of a balance and coupee.

BURR-PUMP, or *Bilge-Pump*, differs from the common pump, in having a ſtaff, ſix, ſeven, or eight feet long, with a bar of wood, whereto the leather is nailed, and this ſerves inſtead of a box. So two men, ſtanding over the pump, thruſt down this ſtaff, to the middle whereof is faſtened a rope, for ſix, eight, or ten to hale by, thus pulling it up and down.

BURROCK, a ſmall wier or dam, where weels are laid in a river, for the taking of fiſh.

Burroughs' Machine.

Plate CXXXI.

BURROUGHS'S MACHINE for grinding and poliſhing glaſs, invented by Mr Burroughs of Southwark; and for which he received from the ſociety for the encouragement of arts a premium of 70l.

This machine conſiſts of a cog-wheel A (fig. 3.), 12 feet in diameter, carrying 72 cogs; which turn a trundle-head B, one foot four inches in diameter, and furniſhed with eight rounds; and alſo a horizontal ſpur-wheel C, of 12 cogs; and one foot eight inches in diameter. The trundle-head B turns a ſpur-wheel D of 10 cogs, and two feet eight inches in diameter. This ſpur-wheel has two cranks, *a b*, in its ſhaft; one of which *a* gives motion to a wooden frame, *c*, about 34 inches long and 19 broad. On the under ſide of this frame are faſtened by ſcrews 12 pieces of poliſhed metal, each five inches and a half long, and three broad, covered with leather; and underneath theſe poliſhers a glaſs-plate cemented in another frame is placed on the bench *d*, and poliſhed with tripoli by the motion given to the upper frame by the crank *a*. The nuts of the ſcrews which faſten the poliſhers to the upper frame are not ſcrewed cloſe to the wood, in order to give the frame room to play; by which contrivance the perpendicular riſe of the crank is avoided, and the motion of the poliſhers is always parallel and equal. The under frame may be moved by the hand in any direction without ſtopping the machine; by which means the plate, when larger than the poliſhing frame can cover in its motion, will be equally poliſhed in every part.

The other crank *b* gives motion to two other poliſhers marked *n*, *o*, which have an alternate motion by the bending of the crank; they move upon the ſame plate, and have an equal number of poliſhers as that already deſcribed.

The ſame crank alſo gives motion to a contrivance repreſented at *e* for poliſhing ſpectacle-glaſſes. It conſiſts of two ſegments of the ſame ſphere; one concave and the other convex. On the latter the glaſſes are cemented; and poliſhed by the former, which is moved by the crank *b*. The convex ſegment may be moved round by the hand without ſtopping the machine, ſo that all the glaſſes on its ſuperficies will be equally poliſhed.

The other ſpur-wheel C, by means of a crank in its ſhaft, gives motion to another frame *g*, employed in grinding the glaſs plates. The rod *h*, extended from the crank *f* to the frame *g*, is faſtened to the latter by means of a pivot, in order to admit of a rotatory motion, as well as that given it by the crank in a longitudinal direction. This rotatory motion is effected by means of a rod of iron *i*, called a *trigger*, ſharp at the extremity next the frame, where it touches the teeth of an horizontal ſpur-wheel, or circular piece of wood, fixed on the grinding-plate, while the other end is extended three feet two inches to the centre of motion.

But this contrivance, in which the merit of the machine principally conſiſts, will be much better conceived from a ſmall delineation of it by itſelf (fig. 4.), where F is the crank marked *f* in fig. 3. and turned by the ſpur-wheel C in the ſame figure. G is the trigger, three feet two inches long. I, a roll fixed on the trigger for the rod to ſlide on. H, the horizontal ſpur-wheel, eleven inches in diameter, fixed on the grinding plate; the teeth of which are touched by the trigger; but with a very unequal force, as it will wholly depend upon the grinding-plate's being farther from, or nearer to, the centre of motion of the trigger. By this ſimple contrivance, the grinding-plate has a very compound motion, never moving exactly in the ſame track, and therefore muſt grind the plates equally in every part. Several attempts have been made by others for producing the ſame effect: but without ſucceſs; the grinding-plate always follows the ſame track, and conſequently the plates are ground equally.

Burrow || Burſars.

BURROW, SIR JAMES, maſter of the crown office, was elected F. R. S. and F. A. S. 1751. On the death of Mr Weſt in 1772, he was prevailed on to fill the preſident's chair at the royal ſociety till the anniverſary election, when he reſigned it to Sir John Pringle; and Auguſt 10. 1773, when the ſociety preſented an addreſs to his majeſty, he received the honour of knighthood. He publiſhed two volumes of Reports in 1766; two others in 1771 and 1776; and a volume of Deciſions of the Court of King's Bench upon ſettlement caſes from 1732 to 1772 (to which was ſubjoined An Eſſay of Punctuation), in three parts, 4to, 1768, 1772, 1776. The Eſſay was alſo printed ſeparately in 4to, 1773. He publiſhed, without his name, "A few Anecdotes and Obſervations relating to Oliver Cromwell and his family, ſerving to rectify ſeveral errors concerning him," publiſhed by Nicol. Comn. Papadopoli, in his *Hiſtoria Gymnaſii Patavini*, 1763, 4to. He died in 1782.

BURROWS, holes in a warren, ſerving as a covert for rabbits, &c. A coney's coming out of her burrow is called *bolting*. To catch coneys, they ſometimes lay purſe-nets over the burrows, then put in a terrier cloſe muzzled, which making the creature bolt, ſhe is caught in the net.

BURSA, or PRUSA, in *Geography*, the capital of Bithynia in Aſia Minor, ſituated in a fine fruitful plain, at the foot of Mount Olympus, about 100 miles ſouth of Conſtantinople. E. Long. 29. 0. N. Lat. 40. 30.

BURSA-Paſtoris, in *Botany*. See THLASPI.

BURSA, *Burſe*, originally ſignifies a purſe. In middle-age writers it is more particularly uſed for a little college or hall in a univerſity, for the reſidence of ſtudents, called *burſales* or *burſarii*. In the French univerſities it ſtill denotes a foundation for the maintenance of poor ſcholars in their ſtudies. The nomination to burſes is in the hands of the patrons and founders thereof. The burſes of colleges are not benefices, but mere places aſſigned to certain countries and perſons. A burſe becomes vacant by the burſer's being promoted to a cure.

BURSÆ MUCOSÆ. See ANATOMY *Index*.

BURSAR, or BURSER, (*Burſarius*), is uſed in middle-age writers for a treaſurer or caſh-keeper. In this ſenſe we meet with burſars of colleges. Conventual burſars were officers in monaſteries, who were to deliver up their account yearly on the day after Michaelmas. The word is formed from the Latin *burſa*, whence alſo the Engliſh word *purſe*; hence alſo the officer, who in a college is called *burſar*, in a ſhip is called *purſer*.

BURSARS, or *Burſors*, (*Burſarii*), alſo denote thoſe to whom ſtipends are paid out of a burſe or fund appointed for that purpoſe.

BURSARIA, the burſary, or exchequer of collegiate and conventual bodies; or the place of receiving, paying, and accounting by the burſarii or burſers.

BURSE, in matters of commerce, denotes a public edifice in certain cities, for the meeting of merchants to negotiate bills, and confer on other matters relating to money and trade. In this ſenſe, burſe amounts to the ſame with what we otherwiſe call an *exchange*.

The firſt place of this kind to which the name *Burſe* was given, Guicchardin aſſures us was at Bruges; and it took its denomination from a hotel adjoining to it, built by a lord of the family de la Bourſe, whoſe arms, which are three purſes, are ſtill found on the crowning over the portal of the houſe. Catel's account is ſomewhat different, viz. that the merchants of Bruges bought a houſe or apartment to meet in, at which was the ſign of the purſe. From this city the name was afterwards transferred to the like places in others, as in Antwerp, Amſterdam, Bergen in Norway, and London. This laſt, anciently known by the name of the *common burſe of merchants*, had the denomination ſince given it by Queen Elizabeth, of the *royal exchange*. The moſt conſiderable burſe is that of Amſterdam, which is a large building, 230 feet long and 130 broad, round which runs a periſtyle 20 feet wide. The columns of the periſtyle, which are 46, are numbered, for the conveniency of finding people. It will hold 4500 perſons.

In the times of the Romans there were public places for the meeting of merchants in moſt of the trading cities of the empire; that built at Rome, in the 259th year after its foundation, under the conſulate of Appius, Claudius and Publius Servilius, was denominated the *college of merchants*; ſome remains of it are ſtill to be ſeen, and are known by the modern Romans under the name *loggia*. The Hans Towns, after the example of the Romans, gave the name of *colleges* to their burſes.

BURSERA. See BOTANY *Index*.

BURSTEN, denotes a perſon who has a rupture. See RUPTURE.

BURTHEN *of a* SHIP. See BURDEN.

BURTON *upon* TRENT, a town of Staffordſhire, in England. It had formerly a large abbey; and over the river Trent it has now a famous bridge of free ſtone, about a quarter of a mile in length, ſupported by 37 arches. It conſiſts chiefly of one long ſtreet, which runs from the place where the abbey ſtood to the bridge, and has a good market for corn and proviſions. Burton ale is reckoned the beſt of any brought to London. E. Lon. 1. 36. N. Lat. 52. 48.

BURTON, a town of Lincolnſhire in England, ſeated on a hill near the river Trent. It is but a ſmall place, and is ſituated in W. Long. 0. 30. N. Lat. 53. 40.

BURTON, a town of Weſtmoreland in England, ſeated in a valley near a large hill called *Farleton-knot-hill*. It is pretty well built, and lies on the great road from Lancaſter to Carliſle. W. Long. 2. 35. N. Lat. 54. 10.

BURTON, *Robert*, known to the learned by the name of *Democritus junior*, was younger brother to William Burton who wrote "The antiquities of Leiceſterſhire," and born of an ancient family at Lindley, in that county, upon the 8th of February 1576. He was educated in grammatical learning in the free ſchool of Sutton Colefield in Warwickſhire; in the year 1593 was ſent to Brazen-noze college in Oxford; and in 1599 was elected ſtudent of Chriſt-church. In 1616, he had the vicarage of St Thomas, in the weſt ſuburb of Oxford, conferred upon him by the dean and canons of Chriſt-church, to the pariſhioners of which, it is ſaid, that he always gave the ſacrament in wafers; and this, with the rectory of Segrave in Leiceſterſhire, given him ſome time after by George lord Berkeley, he held to the day of his death, which happened in January 1639.

He was a man of general learning; a great philoſopher; an exact mathematician; and (what makes the peculiarity of his character) a very curious calculator of nativities. He was extremely ſtudious, and of a melancholy turn; yet an agreeable companion, and very humorous. *The anatomy of melancholy*, by *Democritus junior*, as he calls himſelf, ſhows, that theſe different qualities were mixed together in his compoſition. This book was printed firſt in 4to, afterwards in folio, in 1624, 1632, 1638, and 1652, to the great emolument of the bookſeller, who, as Mr Wood tells us, got an eſtate by it. Some circumſtances attending his death occaſioned ſtrange ſuſpicions. He died in his chamber at or very near the time which, it ſeems, he had ſome years before predicted from the calculation of his nativity; and this exactneſs made it whiſpered about, that for the glory of aſtrology, and rather than his calculation ſhould fail, he became indeed a *felo de ſe*. This, however, was generally diſcredited; he was buried with due ſolemnity in the cathedral of Chriſt-church, and had a fair monument erected to his memory. He left behind him a very choice collection of books. He bequeathed many to the Bodleian library; and 100l. to Chriſt-church, the intereſt of which was to be laid out yearly in books for their library.

BURTON, *John*, D. D. a learned divine, was born in 1696, at Wembworth, in Devonſhire, of which pariſh his father was rector. He was educated at Corpus Chriſti college, Oxford. In 1725, being then proproctor and maſter of the ſchools, he ſpoke a Latin oration before the determining bachelor, which is entitled "*Heli*; or, An inſtance of a magiſtrate's erring through unſeaſonable lenity;" written and publiſhed with a view to encourage the ſalutary exerciſe of academical diſcipline; and afterwards treated the ſame ſubject ſtill more fully in four Latin ſermons before the univerſity, and publiſhed them with appendixes. He alſo introduced into the ſchools, Locke, and other eminent modern philoſophers, as ſuitable companions to Ariſtotle: and printed a double ſeries of philoſophical queſtions, for the uſe of the younger ſtudents; from which Mr Johnſon of Magdalene college, Cambridge, took the hint of his larger work of the ſame kind, which has gone through ſeveral editions.

When the ſettling of Georgia was in agitation, Dr Bray, juſtly revered for his inſtitution of parochial libraries, Dr Stephen Hales, Dr Berriman, and other learned divines, intreated Mr Burton's pious aſſiſtance in that undertaking. This he readily gave, by preaching before the ſociety in 1732, and publiſhing his ſermon, with an appendix on the ſtate of that colony; and he afterwards publiſhed an account of the deſigns of the aſſociates of the late Dr Bray, with an account of their proceedings.

About the ſame time, on the death of Dr Edward Littleton, he was preſented by Eton college to the vicarage of Maple-Derham, in Oxfordſhire. Here a melancholy ſcene, which too often appears in the manſions of the clergy, preſented itſelf to his view; a widow, with three infant daughters, without a home, without a fortune: from his compaſſion aroſe love, the conſequence of which was marriage; for Mrs Littleton was handſome, elegant, accompliſhed, ingenious, and had great ſweetneſs of temper. In 1760, he exchanged his vicarage of Maple-Derham for the rectory of Worpleſdon in Surrey. In his advanced age, finding his eyes begin to fail him, he collected and publiſhed, in one volume, all his ſcattered pieces, under the title of *Opuſcula miſcellanea*; and ſoon after died, February 11th, 1771.

BURTON, in the ſea-language, a ſmall tackle conſiſting of two ſingle blocks, and may be made faſt any where at pleaſure, for hoiſting ſmall things in and out.

BURY, is ſometimes uſed to denote the hole or den of ſome animal under ground. In this ſenſe we ſay the *bury* of a mole, a tortoiſe, or the like. The grillotalpa, or mole-cricket, digs itſelf a bury with its fore-feet, which are made broad and ſtrong for that purpoſe. Naturaliſts ſpeak of a kind of urchins in the iſland of Maraguan, which have two entries to their buries, one towards the north, the other to the ſouth, which they open and ſhut alternately as the wind happens to lie.

BURY, in *Geography*, a market town of Lancaſhire, about 50 miles ſouth-eaſt of Lancaſter. It is a barony in the family of Albemarle. W. Long. 2. 20. N. Lat. 53. 36.

BURY *St Edmond's*, or *St Edmond's Bury*, the county town of Suffolk, about 12 miles eaſt of Newmarket, and 70 north-eaſt of London. E. Long. 0. 45. N. Lat. 52. 20.

BURYING, the ſame with interment or BURIAL.

BURYING Alive was the puniſhment of a veſtal who had violated her vow of virginity. The unhappy prieſteſs was let down into a deep pit, with bread, water, milk, oil, a lamp burning, and a bed to lie on. But this was only for ſhow; for the moment ſhe was let down, they began to caſt in the earth upon her till the pit was filled up †. Some middle-age writers ſeem to make burying alive (*defoſſio*) the puniſhment of a woman thief. Lord Bacon gives inſtances of the reſurrection of perſons who have been buried alive. The famous Duns Scotus is of the number; who, having been ſeized with a catalepſis, was thought dead, and laid to ſleep among his fathers, but raiſed again by his ſervant in whoſe abſence he had been buried. Bartholin gives an account of a woman, who, on recovering from an apoplexy, could not be convinced but that ſhe was dead, and ſolicited ſo long and ſo earneſtly to be buried, that they were forced to comply; and performed the ceremonies, at leaſt in appearance. The famous emperor Charles V. after his abdication, took it into his head to have his burial celebrated in his lifetime, and aſſiſted at it. See CHARLES V.

BURYING-Place. The ancients buried out of cities and towns; an uſage which we find equally among Jews, Greeks, and Romans. Among the laſt, burying within the walls was expreſsly prohibited by a law of the 12 tables. The uſual places of interment were in the ſuburbs and fields, but eſpecially by the way-ſides. We have inſtances, however, of perſons buried in the city; but it was a favour allowed only to a few of ſingular merit in the commonwealth. Plutarch ſays, thoſe who had triumphed were indulged in it. Be this as it will, Val. Publicola, and C. Fabricius, are ſaid to have had tombs in the forum: and Cicero adds Tubertus to the number. Lycurgus allowed his Lacedemonians to bury their dead within the city and around their temples, that the youth, being inured to ſuch ſpectacles, might be the leſs terrified with the apprehenſion of death. Two reaſons are alleged why the ancients buried out of cities: the firſt, an opinion that the ſight, touch, or even neighbourhood, of a corpſe defiled a man, eſpecially a prieſt; whence that rule in A. Gellius, that the *flamen Dialis* might not on any account enter a place where there was a grave: the ſecond, to prevent the air from being corrupted by the ſtench of putrified bodies, and the buildings from being endangered by the frequency of funeral fires.

Burying in churches was not allowed for the firſt 300 years after Chriſt; and the ſame was ſeverely prohibited by the Chriſtian emperors for many ages afterwards. The firſt ſtep towards it appears to have been the practice of erecting churches over the graves of ſome martyrs in the country, and tranſlating the relics of others into churches in the city; the next was, allowing kings and emperors to be buried in the atrium or church-porch. In the 6th century, the people began to be admitted into the church-yards; and ſome princes, founders, and biſhops, into the church. From that time the matter ſeems to have been left to the diſcretion of the biſhop.

BUSBEC, AUGER GISLEN, LORD OF, a perſon illuſtrious on account of his embaſſies, was born at Commines in the year 1522; and educated at the moſt famous univerſities, at Louvain, at Paris, at Venice, at Bologna, and at Padua. He was engaged in ſeveral important employments and negotiations, and particularly was twice ſent ambaſſador by the king of the Romans to the emperor Soliman. He collected inſcriptions; bought manuſcripts; ſearched after rare plants; inquired into the nature of animals; and in his ſecond journey to Conſtantinople, carried with him a painter, that he might be able to communicate to the curious the figures, at leaſt, of the plants and animals that were not well known in the weſt. He wrote a Diſcourſe of the State of the Ottoman empire, and a Relation of his two Journeys to Turkey, which are much eſteemed. He died in 1592.

BUSBY, DR RICHARD, ſon of a gentleman in Weſtminſter, was born at Lutton in Lincolnſhire in 1606. He paſſed through the claſſes in Weſtminſter ſchool, as king's ſcholar; and completed his ſtudies at Chriſt-church, Oxford. In 1640 he was appointed maſter of Weſtminſter ſchool; and by his ſkill and diligence in the diſcharge of this important and laborious office, for the ſpace of 55 years, bred up the greateſt number of eminent men, in church and ſtate, that ever at one time adorned any age or nation. He was extremely ſevere in his ſchool; though he applauded wit

† See the article *Veſtals*.

uſh.

in his ſcholars, even when it reflected on himſelf. This great man, after a long and healthy life, purchaſed by temperance, died in 1695, aged 89; and was buried in Weſtminſter abbey, where there is a fine monument erected for him, with a Latin inſcription. He compoſed ſeveral books for the uſe of his ſchool.

BUSH, Paul, the firſt biſhop of Briſtol, became a ſtudent in the univerſity of Oxford about the year 1513, and in 1518 took the degree of bachelor of arts. He afterwards became a brother of the order called *bonhoms*; of which, after ſtudying ſome time among the friars of St Auſtin (now Wadham college), he was elected provincial. In that ſtation he lived many years; till at length King Henry VIII. being informed of his great knowledge in divinity and phyſic, made him his chaplain, and in 1542 appointed him to the new epiſcopal ſee of Briſtol: but having in the reign of Edward VI. taken a wife, he was, on the acceſſion of Mary, deprived of his dignity, and ſpent the remainder of his life in a private ſtation at Briſtol, where he died in the year 1558, aged 68, and was buried on the north ſide of the choir of the cathedral. Wood ſays, that while he was a ſtudent at Oxford, he was numbered among the celebrated poets of that univerſity; and Pits gives him the character of a faithful Catholic, his want of chaſtity notwithſtanding. He wrote, 1. An exhortation to Margaret Burgeſs, wife to John Burgeſs, clothier, of King's Wood, in the county of Wilts. Lond. printed in the reign of Edward VI. 8vo. 2. Notes on the Pſalms. 3. Treatiſe in praiſe of the croſs. 4. Anſwer to certain queries concerning the abuſe of the maſs. Records, N° 25. 5. Dialogues between Chriſt and the Virgin Mary. 6. Treatiſe of ſalves and curing remedies. 7. A little treatiſe in Engliſh, called *The extirpation of ignorancy*, &c. in verſe. Lond. by Pinſon, 4to. 8. *Carmina diverſa*.

Bush, a term uſed for ſeveral ſhrubs of the ſame kind growing cloſe together: thus we ſay, a *furze-buſh*, *bramble-buſh*, &c.

Bush is ſometimes uſed, in a more general ſenſe, for any aſſemblage of thick branches interwoven and mixed together.

Bush alſo denotes a coronated frame of wood hung out as a ſign of taverns. It takes the denomination from hence, that, anciently, ſigns where wine was ſold were *buſhes* chiefly of ivy, cypreſs, or the like plant, which keeps its verdure long. And hence the Engliſh proverb, "Good wine needs no *buſh*."

Burning-Bush, that buſh wherein the Lord appeared to Moſes at the foot of Mount Horeb, as he was feeding his father-in-law's flocks.

As to the perſon that appeared in the buſh, the text ſays, "That the angel of the Lord appeared unto him in a flame of fire, out of the middle of the buſh;" but whether it was a created angel, ſpeaking in the perſon of God, or God himſelf, or (as the moſt received opinion is) Chriſt the Son of God, has been matter of ſome controverſy among the learned. Thoſe who ſuppoſe it no more than an angel, ſeem to imply that it would be a diminution of the Majeſty of God, to appear upon every occaſion, eſpecially when he has ſuch a number of celeſtial miniſters, who may do the buſineſs as well. But conſidering that God is preſent everywhere, the notification of his preſence by ſome outward ſign in one determinate place (which is all we mean by his appearance), is in our conception leſs laborious (if any thing laborious could be conceived of God) than a delegation of angels upon every turn from heaven, and ſeems in the main to illuſtrate rather than debaſe the glory of his nature and exiſtenee. But however this be, it is plain that the angel here ſpoken of was no created being, from the whole context, and eſpecially from his ſaying, "I am the Lord God, the Jehovah," &c. ſince this is not the language of angels, who are always known to expreſs themſelves in ſuch humble terms as theſe, "I am ſent from God; I am thy fellow ſervant," &c. It is a vain pretext to ſay, that an angel, as God's ambaſſador, may ſpeak in God's name and perſon; for what ambaſſador of any prince ever yet ſaid, "I am the king?" Since therefore no angel, without the guilt of blaſphemy, could aſſume theſe titles; and ſince neither God the Father nor the Holy Ghoſt, are ever called by the name of *angel*, i. e. "meſſenger, or perſon ſent," whereas God the Son is called by the prophet Malachi (chap. iii. 1.), "The angel of the covenant;" it hence ſeems to follow, that this angel of the Lord was God the Son, who might very properly be called an *angel*, becauſe in the fulneſs of time he was ſent into the world in our fleſh, as a meſſenger from God, and might therefore make theſe his temporary apparitions preſages and forerunners, as it were, of his more ſolemn miſſion. The emblem of the burning-buſh is uſed as the ſeal of the church of Scotland, with this motto: *Nec tamen conſumebatur*; i.e. "Though burning, is never conſumed."

Bushel.

BUSHEL, a meaſure of capacity for things dry; as grains, pulſe, dry fruits, &c. containing four pecks, or eight gallons, or one-eighth of a quarter.

Du Cange derives the word from *buſſellus*, *buſtellus*, or *biſſellus*, a diminutive of *buz*, or *buza*, uſed in the corrupt Latin for the ſame thing; others derive it from *buſſulus*, an *urn*, wherein lots were caſt; which ſeems to be a corruption from *buxulus*. *Buſſellus* appears to have been firſt uſed for a liquid meaſure of wine, equal to eight gallons. *Octo libræ faciunt galonem vini, et octo galones vini faciunt* buſſellum *London, quæ eſt octava pars quarterii.* It was ſoon after transferred to the dry meaſure of corn of the ſame quantity. —*Pondus octo librorum frumenti facit* buſſellum, *de quibus octo conſiſtit quarterium.*

By 12 Henry VII. c. 5. a buſhel is to contain 8 gallons of wheat; the gallon 8 pounds of wheat troy-weight; the pound 12 ounces troy-weight; the ounce 20 ſhillings; and the ſterling 32 grains, or corn of wheat, growing in the midſt of the ear. This ſtandard buſhel is kept in the Exchequer; when being filled with common ſpring water, and the water meaſured before the houſe of commons in 1696, in a regular parallelopiped, it was found to contain 21,456 ſolid inches; and the ſaid water being weighed, amounting to 1131 ounces and 14 penny-weights troy. Beſides the ſtandard or legal buſhel, we have ſeveral local buſhels, of different dimenſions, in different places. At Abington and Andover, a buſhel contains nine gallons: at Appleby and Penrith, a buſhel of peaſe, rye, and wheat, contains 16 gallons: of barley, big, malt, mixt malt, and oats, 20 gallons. A buſhel contains, at Carliſle, 24 gallons; at Cheſter, a buſhel of wheat, rye, &c. contains 32 gallons, and of oats 40: at Dorcheſter, a buſhel of malt and oats contains 10 gallons; at Falmouth, the buſhel of ſtricken coals is 16 gallons, of other things 20, and uſually 21 gallons; at Kingſton upon Thames, the buſhel contains 8½; at Newbury 9; at Wycomb and Reading, 8¾; at Stamford, 16 gallons. Houghton. Collect. tom. i. n. 46. p. 42.

At Paris, the buſhel is divided into 2 half-buſhels; the half-buſhel into 2 quarts; the quart into 2 half-quarts; the half-quart into 2 litrons; and the litron into 2 half-litrons. By a ſentence of the provoſt of the merchants of Paris, the buſhel is to be 8 inches 2½ lines high, and 10 inches in diameter; the quart 4 inches 9 lines high, and 6 inches 9 lines wide; the half-quart 4 inches 3 lines high, and 5 inches diameter; the litron 3½ inches high, and 3 inches 10 lines in diameter. Three buſhels make a minot, 6 a mine, 12 a ſeptier, and 144 a muid. In other parts of France the buſhel varies: 14⅓ buſhels of Amboiſe and Tours make the Paris ſeptier. Twenty buſhels of Avignon make 3 Paris ſeptiers. Twenty buſhels of Blois make 1 Paris ſeptier. Two buſhels of Bourdeaux make 1 Paris ſeptier. Thirty-two buſhels of Rochel make 19 Paris ſeptiers. Oats are meaſured in a double proportion to other grains; ſo that 24 buſhels of oats make a ſeptier, and 248 a muid. The buſhel of oats is divided into 5 picotins, the picotin into 2 half-quarts, or 4 litrons. For ſalt 4 buſhels make one minot, and 6 a ſeptier. For coals 8 buſhels make a minot, 16 a mine, and 320 a muid. For lime, 3 buſhels make a minot, and 48 minots a muid. Such were the meaſures by buſhel before the revolution; for the changes that have ſince taken place, ſee Measure and Weight.

BUSIRIS, in *Ancient Geography*, a city of the Lower Egypt, to the ſouth of Leontopolis, on that branch of the Nile called Buſiriticus: Built by Buſiris, noted for his cruelty, and ſlain by Hercules, (Ovid, Virgil, Diodorus Siculus). Strabo denies ſuch a tyrant ever exiſted; Iſocrates has written his panegyric. In this city there ſtood a grand temple of Iſis, which gave it the appellation of the city of Iſis. It was deſtroyed on a revolt by Diocleſian.

BUSIRITICUS Fluvius, in *Ancient Geography*, that branch of the Nile which empties itſelf at the mouth called Oſtium Pathmeticum, or Phatniticum, (Ptolemy); alſo a part, according to an ancient map, at the Oſtium Mindeſium; this river, or branch, dividing itſelf at Dioſpolis into two branches; called Buſiriticus, from the city of Buſiris, which ſtood on its left, or weſt branch. It is the ſecond branch of the Nile, reckoning from the eaſt.

Buriticus Nomos, in *Ancient Geography*, a prefecture, or diviſion of the Lower Egypt; ſo called from the city Buſiris, (Herodotus, Pliny, Ptolemy.)

BUSITIS, in *Ancient Geography*, a diſtrict of Arabia Deſerta; ſo called from Bus, or Buz, Nahor's ſecond ſon; the country of Elihu, the fourth interlocutor in Job; called *Buzetes*, by the Septuagint.

BUSKIN, a kind of ſhoe, ſomewhat in manner of a boot, and adapted to either foot, and worn by either ſex. This part of dreſs, covering both the foot and mid-leg, was tied underneath the knee; it was very rich and fine, and principally uſed on the ſtage by actors in tragedy. It was of a quadrangular form, and the ſole was ſo thick, as that, by means thereof, men of the ordinary ſtature might be raiſed to the pitch and elevation of the heroes they perſonated. The colour was generally purple on the ſtage; herein it was diſtinguiſhed from the ſock worn in comedy, that being only a low common ſhoe. The buſkin ſeems to have been worn not only by actors but by girls, to raiſe their height; travellers and hunters alſo made uſe of it, to defend themſelves from the mire. In claſſic authors, we frequently find the buſkin uſed to ſignify tragedy itſelf, in regard it was a mark of tragedy on the ſtage. It was alſo to be underſtood for a lofty ſtrain or high ſtyle.

BUSS, in maritime affairs, a ſmall ſea veſſel, uſed by us and the Dutch in the herring fiſhery, commonly from 48 to 60 tons burden, and ſometimes more: a buſs has two ſmall ſheds or cabins, one at the prow and the other at the ſtern; that at the prow ſerves for a kitchen. Every buſs has a maſter, an aſſiſtant, a mate, and ſeamen in proportion to the veſſel's ſize; the maſter commands in chief, and without his expreſs orders, the nets cannot be caſt or taken up; the aſſiſtant has the command after him; and the mate next, whoſe buſineſs is to ſee the ſeamen manage their rigging in a proper manner, to mind thoſe who draw in their nets, and thoſe who kill, gut, and cure the herrings as they are taken out of the ſea: the ſeamen generally engage for a whole voyage in the lump. The proviſions which they take on board the buſſes, conſiſt commonly in biſcuit, oat meal, and dried or ſalt fiſh; the crew being content for the reſt with what freſh fiſh they catch. See Fisheries.

BUST, or Busto, in *Sculpture*, denotes the figure or portrait of a perſon in relievo, ſhowing only the head, ſhoulders, and ſtomach, the arms being lopped off: ordinarily placed on a pedeſtal or conſole.

In ſpeaking of an antique, we ſay the head is marble, and the buſt porphyry, or bronze, that is, the ſtomach and ſhoulders. Felibien obſerves, that though in painting one may ſay a figure appears in buſto, yet it is not properly called a *buſt*, that word being confined to things in relievo.

The buſt is the ſame with what the Latins called *Herma*, from the Greek Hermes, Mercury, the image of that God being frequently repreſented in this manner amongſt the Athenians.

Bust is alſo uſed, eſpecially by the Italians, for the trunk of a human body, from the neck to the hips.

Busta Gallica, was a place in ancient Rome, wherein the bones of the Gauls, who firſt took the city, and were ſlain by Camillus, were depoſited. It differed from *Busta Gallorum*, a place on the Apennines, thus called by reaſon of many thouſands of Gauls killed there by Fabius.

BUSTARD. See Otis, Ornithology *Index*.

BUSTUARIÆ Moechæ, according to ſome, women that were hired to accompany the funeral and lament the loſs of the deceaſed: but others are of opinion, that they were rather the more common proſtitutes, that ſtood among the tombs, graves, and other ſuch lonely places.

BUSTUARII, in Roman antiquity, gladiators who fought about the buſtum or funeral pile of a perſon of diſtinction, that the blood which was ſpilt might ſerve as a ſacrifice to the infernal gods, and render them more propitious to the manes of the deceaſed. This cuſtom was introduced in the room of the more inhuman

man one of ſacrificing captives at the buſtum, or on the tombs of warriors.

BUSTUM, in antiquity, denotes a pyramid or pile of wood, whereon were anciently placed the bodies of the deceaſed, in order to be burnt.

The Romans borrowed the cuſtom of burning their dead from the Greeks. The deceaſed, crowned with flowers, and dreſſed in his richeſt habits, was laid on the buſtum. Some authors ſay, it was only called *buſtum*, after the burning, *quaſi bene uſtum:* before the burning it was more properly called *pyra;* during it, *rogus;* and afterwards, *buſtum*. When the body was only burnt there, and buried elſewhere, the place was not properly called *buſtum*, but *uſtrina*, or *uſtrinum*.

Bustum, in the Campus Martius, was a ſtructure whereon the emperor Auguſtus firſt, and after him the bodies of his ſucceſſors, were burnt. It was built of white ſtone, ſurrounded with an iron palliſade, and planted withinſide with alder trees.

Bustum was alſo figuratively applied to denote any tomb. Whence thoſe phraſes, *facere buſtum*, *violare buſtum*, &c.

Bustum of an Altar, was the hearth or place where the fire was kindled.

BUTCHER, a perſon who ſlaughters cattle for the uſe of the table, or who cuts up and retails the ſame.

Among the ancient Romans, there were three kinds of eſtabliſhed butchers, whoſe office it was to furniſh the city with the neceſſary cattle, and to take care of preparing and vending their fleſh. The ſuarii provided hogs; the pecuarii or boarii, other cattle, eſpecially oxen; and under theſe was a ſubordinate claſs, whoſe office was to kill, called *lanii*, and *carnifices*.

To exerciſe the office of butcher among the Jews with dexterity, was of more reputation than to underſtand the liberal arts and ſciences. They have a book concerning ſhamble-conſtitution; and in caſe of any difficulty, they apply to ſome learned rabbi for advice: nor was any allowed to practiſe this art, without a licenſe in form; which gave the man, upon evidence of his abilities, a power to kill meat, and others to eat what he killed; provided he carefully read every week for one year, and every month the next year, and once a quarter during his life, the conſtitution abovementioned.

We have ſome very good laws for the better regulation and preventing the abuſes committed by butchers. A butcher that ſells ſwine's fleſh meaſled, or dead of the murrain, for the firſt offence ſhall be amerced; for the ſecond, have the pillory; for the third, be impriſoned, and make fine; and for the fourth, abjure the town. Butchers not ſelling meat at reaſonable prices ſhall forfeit double the value, leviable by warrant of two juſtices of the peace. No butcher ſhall kill any fleſh in his ſcalding-houſe, or within the walls of London, on pain to forfeit for every ox ſo killed 12d. and for every other beaſt, 8d. to be divided betwixt the king and the proſecutor.

Butcher-Bird. See Lanius, Ornithology *Index*.

Butcher-Broom. See Ruscus, Botany *Index*.

Butcher-Iſland, in the Eaſt Indies, a ſmall iſland about two miles long and ſcarce one broad. It has its name from cattle being kept there for the uſe of Bombay, from which it is about three miles diſtant. It has a ſmall fort, but of very little conſequence.

BUTE, an iſland lying to the weſt of Scotland, being ſeparated from Cowal, a diſtrict of Argyllſhire, only by a narrow channel. In length it is about 18 miles; the broadeſt part from eaſt to weſt is about five. Part of it is rocky and barren; but from the middle ſouthwards, the ground is cultivated, and produces peaſe, oats, and barley. Here is a quarry of red ſtone, which the natives have uſed in building a fort and chapel in the neighbourhood of Rothſay, which is a very ancient royal borough, head town of the ſhire of Bute and Arran; but very thinly peopled, and maintained chiefly by the herring fiſhery, with the profits of which all the rents of this iſland are chiefly paid. On the north ſide of Rothſay, are the ruins of an ancient fort, with its drawbridge, chapel, and barracks. Here are likewiſe the remains of ſome Daniſh towers. The natives are healthy and induſtrious, ſpeak the Erſe and the dialect of the Lowlands indifferently, and profeſs the Proteſtant religion. The iſland is divided into two pariſhes, accommodated with four churches; and belongs chiefly to the earl of Bute, who poſſeſſes an elegant ſeat on the eaſt ſide of the iſland. The name of this iſle has by ſeveral authors, and in different periods, been very differently written, as *Bete*, *Both*, *Bothe*, *Boot*, but now generally *Bute*. Our ancient writers ſuppoſe that it derived its name from a cell erected therein by St Brendan, an Iriſh abbot who flouriſhed in the 6th century, becauſe in his language ſuch a cell was called *Both*. It is, however, probable, that this name was of great antiquity, ſince we find it denominated *Botis* by the anonymous geographer of Ravenna. It was from very early times part of the patrimony of the Stuarts: large poſſeſſions in it were granted to Sir John Stuart, ſon of Robert II. by his beloved miſtreſs Elizabeth More; and it has continued in that line to the preſent time.

BUTESHIRE, comprehends the iſlands of Bute, Arran, the greater and leſſer Cumbray, and *Inch-marnoc*. This ſhire and that of Caithneſs ſend a member to parliament alternately. The earl of Bute is admiral of the county, by commiſſion from his majeſty; but no way dependent on the lord high admiral of Scotland: ſo that if any maritime caſe occurs within this juriſdiction, (even crimes of as high a nature as murder or piracy), his lordſhip, by virtue of his powers as admiral, is ſufficient judge, or he may delegate his authority to any deputies.

The following is a view of the population of this county at two different periods, taken from the Statiſtical Hiſtory of Scotland.

	Pariſh.	Population. in 1755.	Population in 1790—1798.
Bute.	Rothſay,	2222	4032
	Kingarth,	998	727
Arran.	Kilbride,	1369	2545
	Kilmorie,	2127	3259
	Total,	6866	10,563
			6866
	Increaſe,		3697

BUTEO, the trivial name of a ſpecies of Falco. See Ornithology *Index*.

BUTLER, Charles, a native of Wycomb in the county of Bucks, and a maſter of arts in Magdalen college, Oxford, publiſhed a book with this title, "The principles of muſic in ſinging and ſetting; with the twofold uſe thereof, eccleſiaſtical and civil." Quarto, London 1636. The author of this book was a perſon of ſingular learning and ingenuity, which he manifeſted in ſundry other works enumerated by Wood in the *Athen. Oxon.* Among the reſt is an Engliſh grammar, publiſhed in 1633, in which he propoſes a ſcheme of regular orthography, and makes uſe of characters, ſome borrowed from the Saxon, and others of his own invention, ſo ſingular, that we want types to exhibit them: and of this imagined improvement he appears to have been ſo fond, that all his tracts are printed in like manner with his grammar; the conſequence whereof has been an almoſt general diſguſt to all that he has written. His "Principles of Muſic" is, however, a very learned, curious, and entertaining book; and, by the help of the advertiſement from the printer to the reader, prefixed to it, explaining the powers of the ſeveral characters made uſe of by him, may be read to great advantage, and may be conſidered a judicious ſupplement to Morley's introduction.

Butler, *Samuel*, a celebrated poet, was the ſon of a reputable Worceſterſhire farmer, and was born in 1612. He paſſed ſome time at Cambridge, but was never matriculated in that univerſity. Returning to his native country, he lived ſome years as clerk to a juſtice of peace; where he found ſufficient time to apply himſelf to hiſtory, poetry, and painting. Being recommended to Elizabeth counteſs of Kent, he enjoyed in her houſe, not only the uſe of all kinds of books, but the converſation of the great Mr Selden, who often employed Butler to write letters, and tranſlate for him. He lived alſo ſome time with Sir Samuel Luke, a gentleman of an ancient family in Bedfordſhire, and a famous commander under Oliver Cromwell: and he is ſuppoſed at this time to have wrote, or at leaſt to have planned, his celebrated *Hudibras;* and under that character to have ridiculed the knight. The poem itſelf furniſhes this key; where, in the firſt canto, Hudibras ſays,

> "'Tis ſung, there is a valiant mamaluke
> "In foreign land yclep'd — —
> "To whom we oft have been compar'd
> "For perſon, parts, addreſs, and beard."

After the Reſtoration, Mr Butler was made ſecretary to the earl of Carbury, lord preſident of Wales, who appointed him ſteward of Ludlow caſtle, when the court was revived there. No one was a more generous friend to him than the earl of Dorſet and Middleſex, to whom it was owing that the court taſted his *Hudibras.* He had promiſes of a good place from the earl of Clarendon, but they were never accompliſhed; though the king was ſo much pleaſed with the poem, as often to quote it pleaſantly in converſation. It is indeed ſaid, that Charles ordered him the ſum of 3000l. but the ſum being expreſſed in figures, ſomebody, through whoſe hands the order paſſed, by cutting off a cypher, reduced it to 300l. which, though it paſſed the offices without fees, proved not ſufficient to pay what he then owed; ſo that Butler was not a ſhilling the better for the king's bounty. He died in 1680: and though he met with many diſappointments, was never reduced to any thing like want, nor did he die in debt. Mr Granger obſerves, that Butler "ſtands without rival in burleſque poetry. His Hudibras (ſays he) is in its kind, almoſt as great an effort of genius, as the Paradiſe Loſt itſelf. It abounds with uncommon learning, new rhimes, and original thoughts. Its images are truly and naturally ridiculous. There are many ſtrokes of temporary ſatire, and ſome characters and alluſions which cannot be diſcovered at this diſtance of time."

Butler, *Joſeph*, late biſhop of Durham, a prelate diſtinguiſhed by his piety and learning, was the youngeſt ſon of Mr Thomas Butler, a reputable ſhopkeeper at Wantage in Berkſhire, where he was born in the year 1692. His father, who was a Preſbyterian, obſerving that he had a ſtrong inclination to learning, after his being at a grammar-ſchool, ſent him to an academy in Glouceſterſhire, in order to qualify him for a diſſenting miniſter; and while there, he wrote ſome remarks on Dr Clarke's firſt ſermon at Boyle's lecture. Afterwards, reſolving to conform to the eſtabliſhed church, he ſtudied at Oriel college, where he contracted an intimate friendſhip with Mr Edward Talbot, ſon of the biſhop of Durham, and brother to the lord chancellor, who laid the foundation of his ſubſequent advancement. He was firſt appointed preacher at the Rolls, and rector of Haughton and Stanhope, two rich benefices in the biſhopric of Durham. He quitted the Rolls in 1726; and publiſhed in 8vo, a volume of ſermons, preached at that chapel. After this he conſtantly reſided at Stanhope, in the regular diſcharge of all the duties of his office, till the year 1733, when he was called to attend the lord chancellor Talbot as his chaplain, who gave him a prebend in the church of Rocheſter. In the year 1736, he was appointed clerk of the cloſet to Queen Caroline, whom he attended every day, by her majeſty's ſpecial command, from ſeven to nine in the evening. In 1738 he was appointed to the biſhopric of Briſtol; and not long afterwards to the deanry of St Paul's, London. He now reſigned his living of Stanhope. In the year 1746, he was made clerk of the cloſet to the king; and in 1750, was tranſlated to Durham. This rich preferment he enjoyed but a ſhort time; for he died at Bath, June 16. 1752. His corpſe was interred in the cathedral at Briſtol; where there is a monument, with an inſcription, erected to his memory. He died a bachelor. His deep learning and comprehenſive mind appear ſufficiently in his writings, particularly in that excellent treatiſe entitled, *The Analogy of Religion, natural and revealed, to the Conſtitution and Courſe of Nature*, publiſhed in 8vo, 1736.

Butler, the name anciently given to an officer in the court of France, being the ſame as the grand echanſon, or great cupbearer of the preſent times.

Butler, in the common acceptation of the word, is an officer in the houſes of princes and great men, whoſe principal buſineſs is to look after the wine, plate, &c.

BUTLERAGE of wine, is a duty of 2s. for every ton of wine imported by merchant ſtrangers; being a compoſition in lieu of the liberties and freedoms granted to them by King John and Edward I. by a charter called *charta mercatoria*.

Butlerage was originally the only cuſtom that was payable upon the importation of wines, and was taken and received by virtue of the regal prerogative, for the proper uſe of the crown. But for many years paſt, there having been granted by parliament ſubſidies to the kings of England, and the duty of butlerage not repealed, but confirmed, they have been pleaſed to grant the ſame way to ſome noblemen, who by virtue of ſuch grant, are to enjoy the full benefit and advantage thereof, and may cauſe the ſame to be collected in the ſame manner that the kings themſelves were formerly wont to do.

BUTMENT. Butments of arches are the ſame with buttreſſes. They anſwer to what the Romans call *ſublicas*, the French *culees* and *butees*.

BUTMENTS, or *Abutments*, of a bridge, denote the two maſſives at the end of a bridge, whereby the two extreme arches are ſuſtained and joined with the ſhore on either ſide.

BUTOMUS, the FLOWERING-RUSH, or *Water-gladiole*. See BOTANY *Index*.

BUTRINTO, a port-town of Epirus, or Canina, in Turkey in Europe, ſituated oppoſite to the iſland of Corfu, at the entrance of the gulf of Venice. E. Long. 20. 40. N. Lat. 39. 45.

BUTT is uſed for a veſſel, or meaſure of wine, containing two hogſheads, 126 gallons; otherwiſe called *pipe*. A butt of currants is from 1500 to 2200 pounds weight.

BUTTS, or *Butt-ends*, in the ſea-language, are the fore-ends of all planks under water, as they riſe, and are joined one end to another.—Butt-ends in great ſhips are moſt carefully bolted; for if any one of them ſhould ſpring or give way, the leak would be very dangerous and difficult to ſtop.

BUTTS, the place where archers meet with their bows and arrows to ſhoot at a mark, which is called ſhooting at the *butts*: (See ARCHERY).—Alſo *butts* are the ſhort pieces of land in arable ridges and furrows.

BUTTER, a fat unctuous ſubſtance, prepared from milk by beating or churning.

It was late ere the Greeks appear to have had any notion of butter; their poets make no mention of it, and are yet frequently ſpeaking of milk and cheeſe.

The Romans uſed butter no otherwiſe than as a medicine, never as a food.

According to Beckman, the invention of butter belongs neither to the Greeks nor the Romans. The former, he thinks, derived their knowledge of butter from the Scythians, the Thracians and Phrygians; and the latter from the people of Germany.

The ancient Chriſtians of Egypt burnt butter in their lamps inſtead of oil; and in the Roman churches, it was anciently allowed, during Chriſtmas time, to burn butter inſtead of oil, on account of the great conſumption of it otherwiſe.

Butter is the fat, oily, and inflammable part of the milk. This kind of oil is naturally diſtributed through all the ſubſtance of the milk in very ſmall particles, which are interpoſed betwixt the caſeous and ſerous parts, amongſt which it is ſuſpended by a ſlight adheſion, but without being diſſolved. It is in the ſame ſtate in which oil is in emulſions; hence the ſame whiteneſs of milk and emulſions; and hence, by reſt, the oily parts ſeparate from both theſe liquors to the ſurface, and form a cream. See EMULSION.

When butter is in the ſtate of cream, its proper oily parts are not yet ſufficiently united together to form a homogeneous maſs. They are ſtill half ſeparated by the interpoſition of a pretty large quantity of ſerous and caſeous particles. The butter is completely formed by preſſing out theſe heterogeneous parts by means of continued percuſſion. It then becomes an uniform ſoft maſs.

Freſh butter which has undergone no change, has ſcarce any ſmell; its taſte is mild and agreeable; it melts with a weak heat, and none of its principles are diſengaged by the heat of boiling water. Theſe properties prove, that the oily part of butter is of the nature of the fat, fixed, and mild oils obtained from many vegetable ſubſtances by expreſſion. See OILS.—The half fluid conſiſtence of butter, as of moſt other concrete oily matters, is thought to be owing to a conſiderable quantity of acid united with the oily part; which acid is ſo well combined, that it is not perceptible while the butter is freſh and has undergone no change; but when it grows old, and undergoes ſome kind of fermentation, then the acid is diſengaged more and more; and this is the cauſe that butter, like oils of the ſame kind, becomes rancid by age.

Butter is conſtantly uſed in food, from its agreeable taſte; but to be wholeſome, it muſt be very freſh and free from rancidity, and alſo not fried or burnt; otherwiſe its acrid and even cauſtic acid, being diſengaged, diſorders digeſtion, renders it difficult and painful, excites acrid empyreumatic belchings, and introduces much acrimony into the blood. Some perſons have ſtomachs ſo delicate, that they are even affected with theſe inconveniencies by freſh butter and milk. This obſervation is alſo applicable to oil, fat, chocolate, and in general to all oleaginous matters.

For the making of butter ſee AGRICULTURE *Index*.

The trade in butter is very conſiderable. Some compute 50,000 tons annually conſumed in London. It is chiefly made within 40 miles round the city. Fifty thouſand firkins are ſaid to be ſent yearly from Cambridge and Suffolk alone: each firkin containing 56lbs. Utoxeter in Staffordſhire is a market famous for good butter, inſomuch that the London merchants have eſtabliſhed a factory there for that article. It is bought by the pot, of a long cylindrical form, weighing 14lb.

Shower of BUTTER. Naturaliſts ſpeak of ſhowers and dews of a butyraceous ſubſtance. In 1695, there fell in Ireland, during the winter and enſuing ſpring, a thick yellow dew, which had the medicinal properties of butter.

BUTTER, among chemiſts, a name given to ſeveral preparations, on account of their conſiſtence reſembling that of butter; as butter of antimony, &c. See CHEMISTRY *Index*.

Butter-Bur. See TUSSILAGO, BOTANY *Index*.

Butter-Milk, the milk which remains after the butter is produced by churning. Butter-milk is eſteemed an excellent food, in the ſpring eſpecially, and is particularly recommended in hectic ſevers. Some make curds of butter-milk, by pouring into it a quantity of new-milk hot.

Butter-Wort. See PINGUICULA, BOTANY *Index*.

BUTTERFLY, the Engliſh name of a numerous genus of inſects. See PAPILIO, ENTOMOLOGY *Index*.

Butterfly-Shell. See VOLUTA, CONCHOLOGY *Index*.

Method of preſerving Butterflies. See INSECTS.

Edward's Hiſt. of Birds, p. 122. vol. ii.

Method of making Pictures of Butterflies. "Take butterflies or field moths, either thoſe catched abroad, or ſuch as are taken in caterpillars and nurſed in the houſe till they be flies; clip off their wings very cloſe to their bodies, and lay them on clean paper, in the form of a butterfly when flying; then have ready prepared gum arabic that hath been ſome time diſſolved in water, and is pretty thick; if you put a drop of ox-gall into a ſpoonful of this, it will be better for the uſe; temper them well with your finger, and ſpread a little of it on a piece of thin white paper, big enough to take both ſides of your fly; when it begins to be clammy under your finger, the paper is in proper order to take the feathers from the wings of the fly; then lay the gummed ſide on the wings, and it will take them up: then double your paper ſo as to have all the wings between the paper; then lay it on a table, preſſing it cloſe with your fingers; and you may rub it gently with ſome ſmooth hard thing; then open the paper and take out the wings, which will come forth tranſparent: the down of the upper and under ſide of the wings, ſticking to the gummed paper, form a juſt likeneſs of both ſides of the wings in their natural ſhapes and colours. The nicety of taking off flies depends on a juſt degree of moiſture of the gummed paper: for if it be too wet, all will be blotted and confuſed; and if too dry, your paper will ſtick ſo faſt together, that it will be torn in ſeparation. When you have opened your gummed papers, and they are dry, you muſt draw the bodies from the natural ones, and paint them in water colours: you muſt take paper that will bear ink very well for this uſe; for ſinking paper will ſeparate with the reſt, and ſpoil all."

BUTTERIS, in the manege, an inſtrument of ſteel, fitted to a wooden handle, wherewith they pare the foot, or cut off the hoof, of a horſe.

BUTTOCK *of a Ship*, is that part of her which is her breadth right aſtern, from the tack upwards; and a ſhip is ſaid to have a broad or a narrow buttock, according as ſhe is built broad or narrow at the tranſum.

BUTTON, an article in dreſs, whoſe form and uſe are too well known to need deſcription. They are made of various materials, as mohair, ſilk, horſe hair, metal, &c.

Method of making common Buttons. Common buttons are generally made of mohair; ſome indeed are made of ſilk, and others of thread; but the latter are of a very inferior ſort. In order to make a button, the mohair muſt be previouſly wound on a bobbin; and the mould fixed to a board by means of a bodkin thruſt through the hole in the middle of it. This being done, the workman wraps the mohair round the mould in three, four, or ſix columns, according to the button.

Horſe-hair Buttons. The moulds of theſe buttons are covered with a kind of ſtuff compoſed of ſilk and hair; the warp being belladine ſilk, and the ſhoot horſe hair. This ſtuff is wove with two ſelvages, in the ſame manner and in the ſame loom as ribbands. It is then cut into ſquare pieces proportional to the ſize of the button, wrapped round the moulds, and the ſelvages ſtitched together, which form the under part of the button.

Cleanſing of Buttons. A button is not finiſhed when it comes from the maker's hands; the ſuperfluous hair and hubs of ſilk muſt be taken off, and the button rendered gloſſy and beautiful before it can be ſold. This is done in the following manner: A quantity of buttons are put into a kind of iron ſieve, called by workmen a *ſingeing box*. Then a little ſpirit of wine being poured into a kind of ſhallow iron diſh, and ſet on fire, the workman moves and ſhakes the ſingeing box, containing the buttons, briſkly over the flame of the ſpirit, by which the ſuperfluous hairs, hubs of ſilk, &c. are burnt off, without damaging the buttons. Great care, however, muſt be taken that the buttons in the ſingeing box be kept continually in motion; for if they are ſuffered to reſt over the flame, they will immediately burn. When all theſe looſe hairs, &c. are burnt off by the flame of the ſpirit, the buttons are taken out of the ſingeing box, and put, with a proper quantity of the crumbs of bread, into a leather bag, about three feet long, and of a conical ſhape; the mouth or ſmaller end of which being tied up, the workman takes one of the ends in one hand, and the other in the other, and ſhakes the hand briſkly with a particular jerk. This operation cleanſes the buttons, renders them very gloſſy, and fit for ſale.

Gold-twiſt Buttons. The mould of theſe buttons is firſt covered in the ſame manner with that of common buttons. This being done, the whole is covered with a thin plate of gold or ſilver, and then wrought over of different forms, with purple and gimp. The former is a kind of thread compoſed of ſilk and gold wire twiſted together; and the latter, capillary tubes of gold or ſilver, about the tenth of an inch long. Theſe are joined together by means of a fine needle, filled with ſilk, thruſt through their apertures, in the ſame manner as beads or bugles.

The manner of making Metal Buttons. The metal with which the moulds are intended to be covered is firſt caſt into ſmall ingots, and then flatted into thin plates or leaves, of the thickneſs intended, at the flatting mills; after which it is cut into ſmall round pieces proportionable to the ſize of the mould they are intended to cover, by means of proper punches on a block of wood covered with a thick plate of lead. Each piece of metal thus cut out of the plate is reduced into the form of a button, by beating it ſucceſſively in ſeveral cavities, or concave moulds, of a ſpherical form, with a convex puncheon of iron, always beginning with the ſhalloweſt cavity of the mould, and proceeding to the deeper, till the plate has acquried the intended form: and the better to manage ſo thin a plate, they form ten, twelve, and ſometimes even twenty-four, to the cavities, or concave moulds, at once; often nealing the metal during the operation, to make it more ductile. This plate is generally called by workmen the *cap of the button*.

The form being thus given to the plates or caps, they ſtrike the intended impreſſion on the convex ſide, by means of a ſimilar iron puncheon, in a kind of mould engraven *en creux*, either by the hammer or the preſs uſed in coining. The cavity or mould, wherein the impreſſion is to be made, is of a diameter and depth ſuitable to the ſort of button intended to be ſtruck in it; each kind requiring a particular mould. Between the puncheon and the plate is placed a thin piece of lead, called by workmen a *hob*, which greatly contributes to the taking off all the ſtrokes of the engraving; the lead, by reaſon of its ſoftneſs, eaſily giving way to the parts that have relievo, and as eaſily inſinuating itſelf into the traces or indentures.

The plate thus prepared makes the cap or ſhell of the button. The lower part is formed of another plate, in the ſame manner, but much flatter, and without any impreſſion. To the laſt or under plate is ſoldered a ſmall eye made of wire, by which the button is to be faſtened.

The two plates being thus finiſhed, they are ſoldered together with ſoft ſolder, and then turned in a lathe. Generally indeed they uſe a wooden mould, inſtead of the under plate; and in order to faſten it, they paſs a thread or gut acroſs, through the middle of the mould, and fill the cavity between the mould and the cap with cement, in order to render the button firm and ſolid; for the cement entering all the cavities formed by the relievo of the other ſide, ſuſtains it, prevents its flattening, and preſerves its boſſe or deſign.

Button, in the manege. Button of the reins of a bridle, is a ring of leather, with the reins paſſed through it, which runs all along the length of the reins. To put a horſe under the button, is when a horſe is ſtopped without a rider upon his back, the reins being laid on his neck, and the button lowered ſo far down that the reins bring in the horſe's head, and fix it to the true poſture or carriage. It is not only the horſes which are managed in the hand that muſt be put under the button; for the ſame method muſt be taken with ſuch horſes as are bred between two pillars, before they are backed.

Button-Wood. See CEPHALANTHUS, BOTANY *Index*.

Button's-Bay, the name of the north part of Hudſon's bay, in North America, by which Sir Thomas Button attempted to find out a north-weſt paſſage to the Eaſt Indies. It lies between 80° and 100° weſt longitude, and between 60° and 66° north latitude.

Button-Stone, in *Natural Hiſtory*, a kind of figured ſtone, ſo denominated from its reſembling the button of a garment. Dr Hook gives the figure of three ſorts of button-ſtones, which ſeem to have been nothing elſe but the filling up of three ſeveral ſorts of ſhells. They are all of them very hard flints; and have this in common, that they conſiſt of two bodies, which ſeem to have been the filling up of two holes or vents in the ſhell. Dr Plot deſcribes a ſpecies finely ſtriated from the top, after the manner of ſome hair buttons. This name is alſo given to a peculiar ſpecies of ſlate found in the marquiſate of Bareith, in a mountain called *Fichtelberg*; which is extremely different from the common ſorts of ſlate, in that it runs with great eaſe into glaſs in five or ſix hours time, without the addition of any ſalt or other foreign ſubſtance, to promote its vitrification, as other ſtones require. It contains in itſelf all the principles of glaſs, and really has mixed in its ſubſtance the things neceſſary to be added to promote the fuſion of other ſtony bodies. The Swedes and Germans make buttons of the glaſs produced from it, which is very black and ſhining, and it has hence its name *button-ſtone*. They make ſeveral other things alſo of this glaſs, as the handles of knives and the like, and ſend a large quantity of it unwrought in round cakes, as it cools from the fuſion, into Holland.

BUTTRESS, a kind of butment built archwiſe, or a maſs of ſtone or brick, ſerving to prop or ſupport the ſides of a building, wall, &c. on the outſide, where it is either very high, or has any conſiderable load to ſuſtain on the other ſide, as a bank of earth, &c.—Buttreſſes, are uſed againſt the angles of ſteeples and other buildings of ſtone, &c. on the outſide, and along the walls of ſuch buildings as have great and heavy roofs, which would be ſubject to thruſt the walls out, unleſs very thick, if no buttreſſes were placed againſt them. They are alſo placed for a ſupport and butment againſt the feet of ſome arches, that are turned acroſs great halls in old palaces, abbeys, &c.

BUTUS, in *Ancient Geography*, a town of Lower Egypt, on the weſt ſide of the branch of the Nile, called *Thermuthiacus*; towards the mouth called *Oſtium Sebennyticum*: in this town ſtood an oracle of Latona, (Strabo, Herodotus). Ptolemy places Butus in the Nomos Phthenotes: it is alſo called *Buto, -us*, (Herodotus, Stephanus). It had temples of Apollo and Diana, but the largeſt was that of Latona, where the oracle ſtood.

BUTZAW, a town of Lower Saxony, in Germany; it ſtands upon the river Varnow, on the road from Schwerin to Roſtock, lying in E. Long. 13. 12. N. Lat. 54. 50.

BUVETTE, or Beuvette, in the French laws, an eſtabliſhed place in every court, where the lawyers and counſellors may retire, warm themſelves, and take a glaſs of wine by way of refreſhment, at the king's charge. There is one for each court of parliament, but theſe are only for perſons belonging to that body; there are others in the *palais*, whither other perſons alſo reſort.

BUXENTUM, (Livy, Velleius, Ptolemy, Mela, Pliny); Pyxus, (Strabo, Pliny); a town of Lucania, firſt built by the people of Meſſana, but afterwards deſerted, (Strabo). A Roman colony was ſent thither, (Livy, Velleius): and when found ſtill thin of inhabitants, a new colony was ſent by a decree of the ſenate. Its name is from *buxus*, the box-tree, growing plentifully there. Strabo ſays, the name *Pyxus* includes a promontory, port, and river, under one. Now *Pulicaſtro*, in the Hither Principato of Naples. E. Long. 15. 40. N. Lat. 40. 20.

BUXTON, a place in the peak of Derbyſhire, celebrated for its medicinal waters, and lying in W. Long. 0. 20 N. Lat. 53. 20.

It has been always believed by our antiquaries, that the Romans were acquainted with theſe wells, and had frequented them much, as there is a military way ſtill viſible, called the *Bath-gate*, from Burgh to this place. This was verified about 50 years ago, when Sir Thomas Delves, of Cheſhire, in memory of a cure he received here, cauſed an arch to be erected; in digging the foundation for which, they came to the remains of a ſolid and magnificent ſtructure of Roman workmanſhip; and in other places of the neighbourhood, very capacious leaden veſſels, and other utenſils of Roman workmanſhip, have been diſcovered. Theſe waters have always been reckoned inferior to thoſe in Somerſetſhire; but ſeem never to have been totally diſuſed. They are mentioned by Leland, as well known 200 years ago; but it is certain they were brought into greater credit by Dr Jones in 1572, and by George earl of Shrewſbury, who erected a building over the bath, then compoſed of nine ſprings. This building was afterwards pulled down, and a more commodious one erected at the expence of the earl of Devonſhire. In doing this, however, the ancient regiſter of cures drawn up by the bath-warden, or phyſician attending the baths, and ſubſcribed by the hands of the patients, was loſt.

The warm waters of Buxton are, the bath, conſiſting of nine ſprings, as already mentioned, St Ann's well, and St Peter's or Bingham well. St Ann's well riſes at the diſtance of ſomewhat more than 32 yards north-eaſt from the bath. It is chiefly ſupplied from a ſpring on the north ſide, out of a rock of black limeſtone or baſtard marble. It formerly roſe into a ſtone baſon, ſhut up within an ancient Roman brick wall, a yard ſquare within, a yard high on three ſides, and open on the fourth. But, in 1709, Sir Thomas Delves, as already mentioned, erected an arch over it which ſtill continues. It is 12 feet long, and as many broad, ſet round with ſtone ſteps on the inſide. In the midſt of this dome the water now ſprings up into a ſtone baſon two feet ſquare. St Peter's or Bingham well riſes about 20 yards ſouth-eaſt of St Ann's. It is alſo called *Leigh's well*, from a memorable cure received from it by a gentleman of that name. It riſes out of a black limeſtone, in a very dry ground; and is not ſo warm as St Ann's well.

From the great reſort of company to the waters, this place has grown into a large ſtraggling town, which is daily increaſing. The houſes are chiefly, or rather ſolely, built for the reception of invalids; and many of them are not only commodious, but elegant. The duke of Devonſhire has lately erected a moſt magnificent building in the form of a creſcent, with piazzas, under which the company walk in wet or cold weather. It is divided into different hotels, ſhops, &c. with a public coffee-room, and a very elegant room for aſſemblies and concerts.

The hot water reſembles that of Briſtol. It has a ſweet and pleaſant taſte. It contains the calcareous earth, together with a ſmall quantity of ſea-ſalt, and an inconſiderable portion of a purging ſalt; but no iron can be diſcovered in it. This water taken inwardly is eſteemed good in the diabetes; in bloody urine; in the bilious cholic; in loſs of appetite, and coldneſs of the ſtomach; in inward bleedings; in atrophy; in contraction of the veſſels and limbs, eſpecially from age; in cramps and convulſions; in the dry aſthma without a fever; and alſo in barrenneſs. Inwardly and outwardly, it is ſaid to be good in rheumatic and ſcorbutic complaints; in the gout; in inflammation of the liver and kidneys, and in conſumptions of the lungs; alſo in old ſtrains; in hard callous tumours; in withered and contracted limbs; in the itch, ſcabs, nodes, chalky ſwellings, ring worms, and other ſimilar complaints.—Beſides the hot water, there is alſo a cold chalybeate water, with a rough irony taſte: It reſembles the Tunbridge water in virtues.

For the methods of compoſing artificial Buxton water, or of impregnating the original water with a greater quantity of its own gas or with other gaſes, ſee WATERS, *Medicinal*

BUXTON, *Jedediah*, a prodigy with reſpect to ſkill in numbers. His father, William Buxton, was ſchoolmaſter of the ſame pariſh where he was born in 1704: yet Jedediah's education was ſo much neglected, that he was never taught to write; and with reſpect to any other knowledge but that of numbers, ſeemed always as ignorant as a boy of ten years of age. How he came firſt to know the relative proportions of numbers, and their progreſſive denominations, he did not remember; but to this he applied the whole force of his mind, and upon this his attention was conſtantly fixed, ſo that he frequently took no cognizance of external objects, and when he did, it was only with reſpect to their numbers. If any ſpace of time was mentioned, he would ſoon after ſay it was ſo many minutes; and if any diſtance of way, he would aſſign the number of hair breadths, without any queſtion being aſked, or any calculation expected by the company. When he once underſtood a queſtion, he began to work with amazing facility, after his own method, without the uſe of a pen, pencil, or chalk, or even underſtanding the common rules of arithmetic as taught in the ſchools. He would ſtride over a piece of land or a field, and tell you the contents of it almoſt as exact as if you had meaſured it by the chain. In this manner he meaſured the whole lordſhip of Elmton, of ſome thouſand acres, belonging to Sir John Rhodes, and brought him the contents, not only in acres, roods, and perches, but even in ſquare inches. After this, for his own amuſement, he reduced them into ſquare hair-breadths, computing 48 to each ſide of the inch. His memory was ſo great, that while reſolving a queſtion, he could leave off, and reſume the operation again where he left off the next morning, or at a week, a month, or at ſeveral months, and proceed regularly till it was completed. His memory would doubtleſs have been equally retentive with reſpect to other objects, if he had attended to other objects with equal diligence; but his perpetual application to figures prevented the ſmalleſt acquiſition of any other knowledge. He was ſometimes aſked, on his return from church, whether he remembered the text, or any part of the ſermon; but it never appeared that he brought away one ſentence, his mind, upon a cloſer examination, being found to have been buſied, even during divine ſervice, in his favourite operation, either dividing ſome time, or ſome ſpace, into the ſmalleſt known parts, or reſolving ſome queſtion that had been given him as a teſt of his abilities.

This extraordinary perſon living in laborious poverty, his life was uniform and obſcure. Time, with reſpect to him, changed nothing but his age; nor did the ſeaſons vary his employment, except that in winter he uſed a flail, and in ſummer a ling-hook. In the year 1754, he came to London, where he was introduced to the royal ſociety, who, in order to prove his abilities, aſked him ſeveral queſtions in arithmetic, and he gave them ſuch ſatisfaction, that they diſmiſſed him with a handſome gratuity. In this viſit to the metropolis,

polis, the only object of his curioſity, except figures, was his deſire to ſee the king and royal family; but they being juſt removed to Kenſington, Jedediah was diſappointed. During his reſidence in London, he was taken to ſee King Richard III. performed at Drury-lane playhouſe; and it was expected, either that the novelty and the ſplendour of the ſhow would have fixed him in aſtoniſhment, or kept his imagination in a continual hurry; or that his paſſions would, in ſome degree, have been touched by the power of action, if he had not perfectly underſtood the dialogue. But Jedediah's mind was employed in the playhouſe juſt as it was employed in every other place. During the dance, he fixed his attention upon the number of ſteps; he declared, after a fine piece of muſic, that the innumerable ſounds produced by the inſtruments had perplexed him beyond meaſure; and he attended even to Mr Garrick, only to count the words that he uttered, in which he ſaid he perfectly ſucceeded. Jedediah returned to the place of his birth, where, if his enjoyments were few, his wiſhes did not ſeem to be more. He applied to his labour, by which he ſubſiſted, with cheerfulneſs; he regretted nothing that he left behind him in London; and it continued to be his opinion, that a ſlice of ruſty bacon afforded the moſt delicious repaſt.

BUXTORF, John, a learned profeſſor of Hebrew at Baſil, who, in the 17th century, acquired the higheſt reputation, for his knowledge of the Hebrew and Chaldee languages. He died of the plague at Baſil in 1629, aged 65. His principal works are, 1. A ſmall but excellent Hebrew grammer; the beſt edition of which is that of Leyden in 1701, reviſed by Leuſden, 2. A treaſure of the Hebrew grammer. 3. A Hebrew concordance, and ſeveral Hebrew lexicons. 4. *Inſtitutio epiſtolaris Hebraica*. 5. *De abbreviaturis Hebræorum*, &c.

Buxtorf, *John*, the ſon of the former, and a learned profeſſor of the oriental languages at Baſil, diſtinguiſhed himſelf, like his father, by his knowledge of the Hebrew language, and his rabbinical learning. He died in Baſil in 1664, aged 65 years. His principal works are, 1. His tranſlation of the *More Nevochim*, and the *Cozri*. 2. A Chaldee and Syriac lexicon. 3. An anticritic againſt Cappel. 4. A treatiſe on the Hebrew points and accents againſt the ſame Cappel.

BUXUS, the box-tree. See Botany *Index*.

BUYING, the act of making a purchaſe, or of acquiring the property of a thing for a certain price.

Buying ſtands oppoſed to ſelling, and differs from borrowing or hiring, as in the former the property of the thing is alienated for perpetuity, which in the latter it is not. By the civil law, perſons are allowed to buy hope, *ſpem precio emere*, that is, to purchaſe the event or expectation of any thing; *e gr.* the fiſh or birds a perſon ſhall catch, or the money he ſhall win in gaming.

There are different ſpecies of buying in uſe among traders: as, buying on one's own account, oppoſed to buying on commiſſion; buying for ready money, which is when the purchaſer pays in actual ſpecie on the ſpot; buying on credit, or for a time certain, is when the payment is not to be preſently made, but in lieu thereof, an obligation given by the buyer for payment at a time future; buying on delivery, is when the goods purchaſed are only to be delivered at a certain time future.

Buying the Refuſal, is giving money for the right or liberty of purchaſing a thing at a fixed price in a certain time to come; chiefly uſed in dealing for ſhares in ſtock. This is ſometimes alſo called by a cant name, *buying the bear*.

Buying the Small-pox, is an appellation given to a method of procuring that diſeaſe by an operation ſimilar to inoculation; frequent in South Wales, where it has obtained time out of mind. It is performed either by rubbing ſome of the *pus* taken out of a puſtule of a variolous perſon on the ſkin, or by making a puncture in the ſkin with a pin dipped in ſuch pus.

BUYS, a town of Dauphiny in France, ſituated on the borders of Provence. E. Long. 5. 20. N. Lat. 44. 25.

BUZANCOIS, a ſmall town of Berry in France, ſituated on the borders of Touraine, in E. Long. 1. 29. N. Lat. 46. 38.

BUZBACH, a town of Germany, in Weſteravia, and the county of Holmes, on the confines of Hanau. E. Long. 10. 51. N. Lat. 50. 22.

BUZET, a ſmall town of France, in Languedoc, ſeated on the river Torne, in E. Long. 1. 45. N. Lat. 43. 47.

BUZZARD, the name of ſeveral ſpecies of the hawk kind. See Falco, Ornithology *Index*.

BYBLUS, in *Ancient Geography*, a town of Phœnicia, ſituated between Berytus and Botrys; it was the royal reſidence of Cinyras; ſacred to Adonis. Pompey delivered it from a tyrant, whom he cauſed to be beheaded. It ſtood at no great diſtance from the ſea, on an eminence (Strabo): near it ran the Adonis into the Mediterranean. Now in ruins.

BYCHOW, a ſmall town of Lithuania in Poland, ſituated on the river Nieper, in E. Long. 30. 2. N. Lat. 53. 57.

BY-laws, are laws made *obiter*, or by the by; ſuch as orders and conſtitutions of corporations for the governing of their members, of court-leets, and courts baron, commoners, or inhabitants in vills, &c. made by common aſſent, for the good of thoſe that made them, in particular caſes whereunto the public law doth not extend; ſo that they bind farther than the common or ſtatute law: guilds and fraternities of trades by letters patent of incorporation, may likewiſe make by-laws for the better regulation of trade among themſelves or with others. In Scotland theſe laws are called laws of *birlaw or burlaw*; which are made by neighbours elected by common conſent in the *birlaw-courts*, wherein knowledge is taken of complaints betwixt neighbour and neighbour; which men ſo choſen are judges and abritrators, and ſtyled *birlaw-men*. And birlaws, according to Skene, are *leges ruſticorum*, laws made by huſbandmen, or townſhips, concerning neighbourhood among them. All by-laws are to be reaſonable, and for the common benefit, not private advantage of particular perſons, and muſt be agreeable to the public laws in being.

BYNG, George, Lord Viſcount Torrington, was the ſon of John Byng, Eſq. and was born in 1663. At the age of 15, he went volunteer to ſea with the king's warrant. His early engagement in this courſe of life give him little opportunity of acquiring learning or cultivating the polite arts; but by his abilities and activity as a naval commander he furniſhed abundant matter for the pens of others. After being ſeveral times advanced, he was in 1702 raiſed to the command of the Naſſau, a third rate, and was at the taking and burning the French fleet at Vigo; and the next year he was made rear-admiral of the red. In 1704, he ſerved in the grand fleet ſent to the Mediterranean under Sir Cloudeſly Shovel, as rear-admiral of the red; and it was he who commanded the ſquadron that attacked, cannonaded, and reduced Gibraltar. He was in the battle of Malaga, which followed ſoon after; and for his behaviour in that action Queen Anne conferred on him the honour of knighthood. In 1705, in about two months time, he took 12 of the enemies largeſt privateers, with the Thetis, a French man of war of 44 guns; and alſo ſeveral merchant ſhips, moſt of them richly laden. The number of men taken on board was 2070, and of guns 334. In 1718 he was made admiral and commander in chief of the fleet; and was ſent with a ſquadron into the Mediterranean for the protection of Italy, according to the obligation England was under by treaty, againſt the invaſion of the Spaniards; who had the year before ſurpriſed Sardinia, and had this year landed an army in Sicily. In this expedition he diſpatched Captain Walton in the Canterbury with five more ſhips, in purſuit of ſix Spaniſh men of war, with galleys, fire-ſhips, bomb-veſſels, and ſtoreſhips, who ſeparated from the main fleet, and ſtood in for the Sicilian ſhore. The captain's laconic epiſtle on this occaſion is worthy of notice; which ſhowed that fighting was his talent as well as his admiral's, and not writing.

> "Sir,
>
> "We have taken and deſtroyed all the Spaniſh ſhips and veſſels which were upon the coaſt, as per margin.
>
> Canterbury, off Syracuſe, I am, &c.
> Auguſt 16. 1718. G. Walton."

From the account referred to, it appeared that he had taken four Spaniſh men of war, with a bomb veſſel and a ſhip laden with arms; and burned four, with a fire-ſhip and bomb-veſſel. The king made the admiral a handſome preſent, and ſent him plenipotentiary powers to negotiate with the princes and ſtates of Italy as there ſhould be occaſion. He procured the emperor's troops free acceſs into the fortreſſes that ſtill held out in Sicily; failed afterwards to Malta, and brought out the Sicilian galleys, and a ſhip belonging to the Turkey company. Soon after he received a gracious letter from the emperor Charles VI. written with his own hand, accompanied with a picture of his imperial majeſty, ſet round with very large diamonds, as a mark of the grateful ſenſe he had of his ſervices. It was entirely owing to his advice and aſſiſtance that the Germans retook the city of Meſſina in 1719, and deſtroyed the ſhips that lay in the baſon; which completed the ruin of the naval power of Spain. The Spaniards being much diſtreſſed, offered to quit Sicily; but the admiral declared, that the troops ſhould never be ſuffered to quit the iſland till the king of Spain had acceded to the quadruple alliance. And to his conduct it was entirely owing that Sicily was ſubdued, and his Catholic majeſty forced to accept the terms preſcribed him by the quadruple alliance. After performing ſo many ſignal ſervices, the king received him with the moſt gracious expreſſions of favour and ſatisfaction; made him rear-admiral of England and treaſurer of the navy, one of his moſt honourable privy-council, Baron Byng of Southill in the county of Bedford, Viſcount Torrington in Devonſhire, and one of the knights companions of the Bath upon the revival of that order. In 1727, George II. on his acceſſion to the crown, placed him at the head of his naval affairs, as firſt lord commiſſioner of the admiralty; in which high ſtation he died January 15. 1733, in the 70th year of his age, and was buried at Southill in Bedfordſhire.

Byng, *the honourable George*, Eſq. the unhappy ſon of the former, was bred to ſea, and roſe to the rank of admiral of the blue. He gave many proofs of courage; but was at laſt ſhot, upon a dubious ſentence, for neglect of duty, in 1757. See Britain.

BYRLAW or *Burlaw Laws* in Scotland. See By-laws.

BYROM, John, an ingenious poet of Mancheſter, born in 1691. His firſt poetical eſſay appeared in the Spectator, N° 603, beginning, "My time, O ye Muſes, was happily ſpent;" which, with two humorous letters on dreams, are to be found in the eighth volume. He was admitted a member of the Royal Society in 1724; and having originally entertained thoughts of practiſing phyſic, to which the title of *doctor* is incident, that was the appellation by which he was always known: but reducing himſelf to narrow circumſtances by a precipitate marriage, he ſupported himſelf by teaching a new method of writing ſhort-hand, of his own invention; until an eſtate devolved to him by the death of an elder brother. He was a man of lively wit; of which, whenever a favourable opportunity tempted him to indulge it, he gave many humorous ſpecimens. He died in 1763; and a collection of his miſcellaneous poems was printed at Mancheſter, in 2 vols 8vo, 1773.

BYRRHUS. See Entomology *Index*.

BYSSUS. See Botany *Index*.

Byssus, or *Byſſum*, a fine thready matter produced in India, Egypt, and about Elis in Achaia, of which the richeſt apparel was anciently made, eſpecially that worn by the prieſts both Jewiſh and Egyptian. Some interpreters render the Greek Βυσσος, which occurs both in the Old and New Teſtament, by *fine linen*. But other verſions, as Calvin's, and the Spaniſh printed at Venice in 1556, explain the word by *ſilk*; and yet byſſus muſt have been different from our ſilk, as appears from a multitude of ancient writers, and particularly from Jul. Pollux. M. Simon, who renders the word by fine linen, adds a note to explain it; viz. that there was a fine kind of linen very dear, which the great lords alone wore in this country as well as in Egypt." This account agrees perfectly well with that given by Heſychius, as well as what is obſerved by Bochart, that the byſſus was a finer kind of linen, which was frequently dyed of a purple colour. Some authors will have the byſſus to be the ſame with our cotton; others take it for the *linum aſbeſtinum*; and others for the lock or bunch of ſilky hair found adhering to the pinna marina, by which it faſtens itſelf to the neighbouring bodies. Authors uſually diſtinguiſh two ſorts of byſſus; that of Elis; and that of Judæa, which was the fineſt. Of this latter were the prieſtly ornaments made. Bonfrerius notes, that there muſt have been two ſorts of byſſes, one finer than ordinary, by reaſon there are two Hebrew words uſed in Scripture to denote byſſus; one of which is always uſed in ſpeaking of the habit of the prieſts, and the other of that of the Levites.

Byssus Aſbeſtinus, a ſpecies of aſbeſtus or incombuſtible flax, compoſed of fine flexible fibres, parallel to one another. It is found plentifully in Sweden, either white, or of different ſhades of green. At a copper mine in Weſtmannland it forms the greateſt part of the vein out of which the ore is dug; and by the heat of the furnace which melts the metal, is changed into a pure ſemitranſparent ſlag or glaſs.

BYZANTIUM, an ancient city of Thrace, ſituated on the Boſphorus. It was founded, according to Euſebius, about the 30th Olympiad, while Tullus Hoſtilius reigned in Rome. But, according to Diodorus Siculus, the foundations of this metropolis were laid in the time of the Argonauts, by one Byſas, who then reigned in the neighbouring country, and from whom the city was called *Byzantium*. This Byſas, according to Euſtathius, arrived in Thrace a little before the Argonauts came into thoſe ſeas, and ſettled there with a colony of Megarenſes. Velleius Paterculus aſcribes the founding of Byzantium to the Mileſians, and Ammianus Marcellinus to the inhabitants of Attica. Some ancient medals of Byzantium, which have reached our times, bear the name and head of Byſas, with the prow of a ſhip on the reverſe. The year after the deſtruction of Jeruſalem by Titus, Byzantium was reduced to the form of a Roman province. In the year 193 this city took part with Niger againſt Severus. It was ſtrongly garriſoned by Niger, as being a place of the utmoſt importance. It was ſoon after inveſted by Severus; and as he was univerſally hated on account of his cruelty, the inhabitants defended themſelves with the greateſt reſolution. They had been ſupplied with a great number of warlike machines, moſt of them invented and built by Periſcus, a native of Nicæa, and the greateſt engineer of his age. For a long time they baffled all the attempts of the aſſailants, killed great numbers of them, cruſhed ſuch as approached the walls with large ſtones; and when ſtones began to fail, they uſed the ſtatues of their gods and heroes. At laſt they were obliged to ſubmit, through famine, after having been reduced to the neceſſity of devouring one another. The conqueror put all the magiſtrates and ſoldiers to the ſword; but ſpared the engineer Periſcus. Before this ſiege, Byzantium was the greateſt, moſt populous, and wealthieſt city of Thrace. It was ſurrounded by walls of an extraordinary height and breadth: and defended by a great number of towers, ſeven of which were built with ſuch art, that the leaſt noiſe heard in one of them was immediately conveyed to all the reſt. Severus, however, no ſooner became maſter of it, than he commanded it to be laid in aſhes. The inhabitants were ſtripped of all their effects, publicly ſold for ſlaves, and the walls levelled with the ground. But by the chronicle of Alexandria we are informed, that ſoon after this terrible cataſtrophe, Severus himſelf cauſed a great part of the city to be rebuilt, calling it *Antonia* from his ſon Caracalla, who aſſumed the ſurname of *Antoninus*. In 262, the tyrant Galienus wreaked his fury on the inhabitants of Byzantium. He intended to beſiege it; but on his arrival deſpaired of being able to make himſelf maſter of ſuch a ſtrong place. He was admitted the next day, however, into the city; and without any regard to the terms he had agreed to, cauſed the ſoldiers and all the inhabitants to be put to the ſword. Trebellius Pollio ſays, that not a ſingle perſon was left alive. What the reaſon was for ſuch an extraordinary maſſacre, we are nowhere informed. In the wars between the emperors Licinius and Maximin the city of Byzantium was obliged to ſubmit to the latter, but was ſoon after recovered by Licinius. In the year 323, it was taken from Licinius by Conſtantine the Great, who in 330 enlarged and beautified it, with a deſign to make it the ſecond, if not the firſt, city in the Roman empire. He began with extending the walls of the ancient city from ſea to ſea; and while ſome of the workmen were buſied in rearing them, others were employed in raiſing within them a great number of ſtately buildings, and among others a palace no way inferior in magnificence and extent to that of Rome. He built a capitol and amphitheatre, made a circus maximus, ſeveral forums, porticoes, and public baths. He divided the whole city into 14 regions, and granted the inhabitants many privileges and immunities. By this means Byzantium became one of the moſt flouriſhing and populous cities of the empire. Vaſt numbers of people flocked thither from Pontus, Thrace, and Aſia, Conſtantine having, by a law, enacted this year (330), decreed, that ſuch as had lands in thoſe countries ſhould not be at liberty to diſpoſe of them, nor even leave them to their proper heirs at their death, unleſs they had a houſe in this new city. But however deſirous the emperor was that his city ſhould be filled with people, he did not care that it ſhould be inhabited by any but Chriſtians. He therefore cauſed all the idols to be pulled down, and all their churches conſecrated to the true God. He built beſides an incredible number of churches, and cauſed croſſes to be erected in all the ſquares and public places. Moſt of the buildings being finiſhed, it was ſolemnly dedicated to the Virgin Mary, according to Cedrenus, but, according to Euſebius, to the God of Martyrs. At the ſame time Byzantium was equalled to Rome. The ſame rights, immunities, and privileges were granted to its inhabitants, as to thoſe of the metropolis. He eſtabliſhed a ſenate and other magiſtrates, with a power and authority equal to thoſe of old Rome. He took up his reſidence in the new city; and changed its name to CONSTANTINOPLE.

BZOVIUS, ABRAHAM, one of the moſt celebrated writers in the 17th century, with reſpect to the aſtoniſhing number of pieces compoſed by him. His chief work is the continuation of Baronius's annals. He was a native of Poland, and a Dominican friar. Upon his coming to Rome, he was received with open arms by the Pope, and had an apartment aſſigned him in the Vatican. He merited that reception, for he has imitated Baronius to admiration, in his deſign of making all things conſpire to the deſpotic power and glory of the papal ſee. He died in 1630, aged 70.

C.

C.
Caaba.

C, THE third letter, and ſecond conſonant, of the alphabet, is pronounced like *k* before the vowels *a*, *o*, and *u*; and like *s* before *e*, *i*, and *y*. C is formed, according to Scaliger, from the ϰ of the Greeks, by retrenching the ſtem or upright line; though others derive it from the כ of the Hebrews, which has in effect the ſame form; allowing only for this, that the Hebrews reading backwards, and the Latins, &c. forwards, each have turned the letter their own way. However the C not being the ſame as to ſound with the Hebrew *caph*, and it being certain the Romans did not borrow their letters immediately from the Hebrews or other orientals, but from the Greeks, the derivation from the Greek ϰ, is the more probable. Add, that F. Montfaucon, in his Palæographia, gives us ſome forms of the Greek ϰ, which come very near to that of our C: thus, for inſtance, ς: and Suidas calls the C the Roman kappa. The ſecond ſound of C reſembles that of the Greek Σ; and many inſtances occur of ancient inſcriptions, in which Σ has the ſame form with our C. All grammarians agree, that the Romans pronounced their Q like our C, and their C like our K. F. Mabillon adds, that Charles the Great was the firſt who wrote his name with a C; whereas all his predeceſſors of the ſame name wrote it with a K; and the ſame difference is obſerved in their coins.

As an abbreviature, C ſtands for Caius, Carolus, Cæſar, *condemno*, &c. and CC for *conſulibus*.

As a numeral, C ſignifies 100, CC 200, &c.

C, in *Muſic*, placed after the cleff, intimates that the muſic is in common time, which is either quick or ſlow, as it is joined with allegro, or adagio: if alone, it is uſually adagio. If the C be croſſed or turned, the firſt requires the air to be played quick, and the laſt very quick.

CAABA, or CAABAH, properly ſignifies a ſquare ſtone building: but is particularly applied by the Mahometans to the temple at Mecca, built, as they pretend, by Abraham and Iſhmael his ſon.

Before the time of Mahomet, this temple was a place of worſhip for the idolatrous Arabs, and is ſaid to have contained no leſs than 360 different images, equalling in number the days of the Arabian year. They were all deſtroyed by Mahomet, who ſanctified the Caaba, and appointed it to be the chief place of worſhip for all true believers. The temple is in length from north to ſouth about 24 cubits; its breadth from eaſt to weſt is 23, and its height 27. The door, which is on the eaſt ſide, ſtands about four cubits from the ground; the floor being level with the bottom of the door. In the corner next this door is the *black ſtone*, ſo much celebrated among the Mahometans. On the north ſide of the Caaba, within a ſemicircular encloſure 50 cubits long, lies the *white ſtone*, ſaid to be the ſepulchre of Iſhmael, which receives the rain water from the Caaba by a ſpout formerly of wood, but now of gold. The black ſtone, according to the Mahometans, was brought down from heaven by Gabriel at the creation of the world, and was originally of a white colour; but contracted the blackneſs that now appears on it from the guilt of thoſe ſins committed by the ſons of men. It is ſet in ſilver, and fixed in the ſouth-eaſt corner of the Caaba, looking towards Baſra, about ſeven ſpans from the ground. This ſtone, upon which there is the figure of a human head, is held in the higheſt eſtimation among the Arabs; all the pilgrims kiſſing it with great devotion, and ſome even calling it the *right hand of God*. Its blackneſs, which is only ſuperficial, is probably owing to the kiſſes and touches of ſo many people. After the Karmatians had taken Mecca, they carried away this precious ſtone, and could by no means be prevailed upon to reſtore it; but finding at laſt that they were unable to prevent the concourſe of pilgrims to Mecca, they ſent it back of their own accord, after having kept it 22 years.

Caaba.

The double roof of the Caaba is ſupported within by three octagonal pillars of aloes wood; between which, on a bar of iron, hang ſome ſilver lamps. The outſide is covered with rich black damaſk, adorned with an embroidered band of gold, which is changed every year, and was formerly ſent by the caliphs, afterwards by the ſultans of Egypt, and is now provided by the Turkiſh emperors. The Caaba, at ſome diſtance, is almoſt ſurrounded by a circular encloſure of pillars, joined towards the bottom by a low balluſtrade, and towards the top by bars of ſilver. Juſt without this inner encloſure, on the ſouth, north, and weſt ſides of the Caaba, are three buildings, which are the oratories or places where three of the orthodox ſects aſſemble to perform their devotions. Towards the ſouth-eaſt ſtands an edifice which covers the well Zemzem, the treaſury, and the cupola of Al Abbas. Formerly there was another cupola, that went under the name of the *hemicycle* or *cupola of Judea*; but whether or not any remains of that are now to be ſeen, is unknown; nor is it eaſy to obtain information in this reſpect, all Chriſtians being denied acceſs to this holy place. At a ſmall diſtance from the Caaba, on the eaſt ſide, is the *ſtation* or *place* of Abraham; where is another ſtone much reſpected by the Mahometans; and where they pretend to ſhow the footſteps of the patriarch, telling us he ſtood on it when he built the Caaba. Here the fourth ſect of Arabs, viz. that of Al Shafei, aſſemble for religious purpoſes.

The ſquare colonnade, or great piazza, which at a conſiderable diſtance encloſes theſe buildings, conſiſts, according to Al Jannabi, of 488 pillars, and has no leſs than 38 gates. Mr Sale compares this piazza to that of the Royal Exchange at London, but allows it to be much larger. It is covered with ſmall domes or cupolas, from the four corners of which riſe as many minarets or ſteeples, with double galleries, and adorned with gilded ſpires and creſcents after the Turkiſh manner, as are alſo the cupolas which cover the piazza and other buildings. Between the columns of both encloſures hang a great number of lamps, which are conſtantly lighted at night. The firſt foundation of this ſecond encloſure was laid by Omar the ſecond caliph, who built no more than a low wall, to prevent the court of the Caaba from being encroached upon by private buildings; but by the liberality of ſucceeding princes, the whole has been raiſed to that ſtate of magnificence in which it appears at preſent.

This temple enjoys the privilege of an aſylum for all ſorts of criminals: but it is moſt remarkable for the pilgrimages made to it by the devout Muſſulmans, who pay ſo great a veneration to it, that they believe a ſingle ſight of its ſacred walls, without any particular act of devotion, is as meritorious in the ſight of God, as the moſt careful diſcharge of one's duty, for the ſpace of a whole year, in any other temple.

CAAMINI, in *Botany*, a name given by the Spaniards and others to the fineſt ſort of Paraguayan tea. It is the leaf of a ſhrub which grows on the mountains of Maracaya, and is uſed in Chili and Peru as the tea is with us. The mountains where this ſhrub grows naturally are far from the inhabited parts of Paraguay: but the people of the place know ſo well the value and uſe of it, that they conſtantly furniſh themſelves with great quantities of it from the ſpot. They uſed to go out on theſe expeditions many thouſands together; leaving their country, in the mean time, expoſed to the inſults of their enemies, and many of themſelves periſhing by fatigue. To avoid theſe inconveniences, they have of late planted theſe trees about their habitations; but the leaves of theſe cultivated ones have not the fine flavour of thoſe that grow wild. The king of Spain has permitted the Indians of Paraguay to bring to the town of Saintfoy 12,000 arobes of the leaves of this tree every year, but they are not able to procure ſo much of the wild leaves annually: about half the quantity is the utmoſt they bring of this: the other half is made up of the leaves of the trees in their own plantations; and this ſells at a lower price, and is called *pabos*. The arobe is about 25 pound weight; the general price is four piaſtres; and the money is always divided equally among the people of the colony.

CAANA, or KAANA, a town in Upper Egypt, ſeated on the eaſtern bank of the river Nile, from whence they carry corn and pulſe for the ſupply of Mecca in Arabia. E. Long. 32. 23. N. Lat. 24. 30. Here are ſeveral monuments of antiquity yet remaining, adorned with hieroglyphics.

CAB, a Hebrew dry meaſure, being the ſixth part of a ſeah or ſatum, and the 18th part of an ephah. A cab contained $2\frac{5}{6}$ pints of our corn-meaſure: a quarter cab was the meaſure of dove's dung, or more properly a ſort of chick-peaſe called by this name, which was ſold at Samaria, during the ſiege of that city, for five ſhekels.

CABAL, an apt name currently given to the infamous miniſtry of Charles II. compoſed of five perſons, Clifford, Aſhley, Buckingham, Arlington, and Lauderdale; the firſt letters of whoſe names, in this order, furniſhed the appellation by which they were diſtinguiſhed.

CABALIST, in French commerce, a factor or perſon who is concerned in managing the trade of another.

CABALLARIA, in middle-age writers, lands held by the tenure of furniſhing a horſeman, with ſuitable equipage in time of war, or when the lord had occaſion for him.

CABALLEROS, or CAVALLEROS, are Spaniſh wools, of which there is a pretty conſiderable trade at Bayonne in France.

CABALLINE, denotes ſomething belonging to horſes; thus caballine aloes is ſo called, from its being chiefly uſed for purging horſes; and common brimſtone is called *ſulphur caballinum* for a like reaſon.

CABALLINUM in *Ancient Geography*, a town of the Ædui in Gallia Celtica; now *Chalons ſur Saone*, which ſee.

CABALLINUS in *Ancient Geography*, a very clear fountain of Mount Helicon in Bœotia; called *Hippocrene* by the Greeks, becauſe opened by Pegaſus on ſtriking the rock with his hoof, and hence called *Pegaſius*.

CABALLIO, or CABELLIO, in *Ancient Geography*, a town of the Cavares in Gallia Narbonenſis, ſituated on the Druentia. One of the Latin colonies, in the Notitiæ called *Civitas Cabellicorum*. Now *Cavaillon* in Provence.

CABBAGE, in *Botany*. See BRASSICA; and AGRICULTURE *Index*.

CABBAGE-Tree or *True CABBAGE-Palm*. See ARECA, BOTANY *Index*

CABBAGE-BARK *Tree*. See GEOFFRÆA, BOTANY *Index*.

CABBALA, according to the Hebrew ſtyle, has a very diſtinct ſignification from that wherein we underſtand it in our language. The Hebrew cabbala ſignifies tradition; and the rabbins, who are called *cabbaliſts*, ſtudy principally the combination of particular words, letters, and numbers, and by this means pretend to diſcover what is to come, and to ſee clearly into the ſenſe of many difficult paſſages of Scripture. There are no ſure principles of this knowledge, but it depends upon ſome particular traditions of the ancients; for which reaſon it is termed *cabbala*.

The cabbaliſts have abundance of names which they call *ſacred*; theſe they make uſe of in invoking of ſpirits, and imagine they receive great light from them. They tell us, that the ſecrets of the Cabbala were diſcovered to Moſes on Mount Sinai; and that theſe have been delivered to them down from father to ſon, without interruption, and without any uſe of letters; for to write them down, is what they are by no means permitted to do. This is likewiſe termed the *oral law*, becauſe it paſſed from father to ſon, in order to diſtinguiſh it from the written laws.

There is another cabbala, called *artificial*, which conſiſts in ſearching for abſtruſe and myſterious ſignifications of a word in Scripture, from whence they borrow certain explanations, by combining the letters which compoſe it; this cabbala is divided into three kinds, the gematric, the notaricon, and the temura or themura. The firſt whereof conſiſts in taking the letters of a Hebrew word for ciphers or arithmetical numbers, and explaining every word by the arithmetical value of the letters whereof it is compoſed. The ſecond ſort of cabbala, called *notaricon*, conſiſts in taking every particular letter of a word for an entire diction; and the third, called *themura*, i. e. change, conſiſts in making different tranſpoſitions or changes of letters, placing one for the other, or one before the other.

Among the Chriſtians, likewiſe, a certain ſort of magic is, by miſtake, called *cabbala;* which conſiſts in uſing improperly certain paſſages of Scripture for magic operations, or in forming magic characters or figures with ſtars and taliſmans.

Some viſionaries among the Jews believe, that Jeſus Chriſt wrought his miracles by virtue of the myſteries of the cabbala.

CABBALISTS, the Jewiſh doctors who profeſs the ſtudy of the cabbala.

In the opinion of theſe men, there is not a word, letter, or accent in the law, without ſome myſtery in it. The Jews are divided into two general ſects; the karaites, who refuſe to receive either tradition or the talmud, or any thing but the pure texts of Scripture; and the rabbiniſts, or talmudiſts, who, beſides this, receive the traditions of the ancients, and follow the talmud.

The latter are again divided into two other ſects; pure rabbiniſts, who explain the Scripture in its natural ſenſe, by grammar, hiſtory, and tradition; and cabbaliſts, who, to diſcover hidden myſtical ſenſes, which they ſuppoſe God to have couched therein, make uſe of the cabbala, and the myſtical methods above mentioned.

CABEGA, or Cabess, a name given to the fineſt ſilks in the Eaſt Indies, as thoſe from 15 to 20 per cent. inferior to them are called *barina* The Indian workmen endeavour to paſs them off one with the other; for which reaſon, the more experienced European merchants take care to open the bales, and to examine all the ſkaines one after another. The Dutch diſtinguiſh two ſorts of cabecas; namely, the moor cabeca, and the common cabeca. The former is ſold at Amſterdam for about 21½ ſchellinghen Flemiſh, and the other for about 18½.

Cabeca *de Vide*, a ſmall ſea-port town of Alentejo, in Portugal, with good walls, and a ſtrong caſtle. W. Long. 6. 43. N. Lat. 39. 0.

CABENDA, a ſea port of Congo, in Africa, ſituated in E. Long. 12. 2. S. Lat. 4. 5.

CABES, or Gabes, a town of Africa in the kingdom of Tunis, ſeated on a river near the gulf of the ſame name. E. Long. 10. 35. N. Lat. 33. 40.

CABEZZO, a province of the kingdom of Angola, in Africa; having Oacco on the north, Lubolo on the ſouth, the Coanzo on the north-eaſt, and the Reimba on the ſouth-weſt. It is populous, and well ſtored with cattle, &c. and hath a mine of iron on a mountain from thence called the *iron mountain*, which yields great quantities of that metal; and this the Portugueſe have taught the natives to manufacture. This province is watered by a river called *Rio Longo*, and other ſmall rivulets, lakes, &c. The trees here are vaſtly large; and they have one ſort not unlike our apple trees, the bark of which being ſlaſhed with a knife, yields an odoriferous reſin of the colour and conſiſtency of wax, and very medicinal in its nature, only a little too hot for Europeans, unleſs qualified by ſome cooling drug.

CABIDOS, or Cavidos, a long meaſure uſed at Goa, and other places of the Eaſt Indies belonging to the Portugueſe, to meaſure ſtuffs, linens, &c. and equal to $\frac{4}{7}$ths of the Paris ell.

CABIN, a room or apartment in a ſhip where any of the officers uſually reſide. There are many of theſe in a large ſhip; the principal of which is deſigned for the captain or commander. In ſhips of the line this chamber is furniſhed with an open gallery in the ſhip's ſtern, as alſo a little gallery on each quarter. The apartments where the inferior officers or common ſailors ſleep and meſs are uſually called Births; which ſee.

The bed places built up for the ſailors at the ſhip's ſide in merchantment are alſo called *cabins*.

CABINDA, the chief port of the kingdom of Angoy in Loango in Africa. It is ſituated at the mouth of a river of the ſame name about five leagues north of Cape Palmerino, on the north ſide of the mouth of the river Zaire. The bay is very commodious for trade, wooding, and watering.

CABINET, the moſt retired place in the fineſt part of a building, ſet apart for writing, ſtudying, or preſerving any thing that is precious.

A complete apartment conſiſts of a hall, antichamber, chamber, and cabinet, with a gallery on one ſide. Hence we ſay, a cabinet of paintings, curioſities, &c.

Cabinet, alſo denotes a piece of joiners workmanſhip, being a kind of preſs or cheſt, with ſeveral doors and drawers.

There are common cabinets of oak or of cheſnut varniſhed, cabinets of China and Japan, cabinets of inlaid-work, and ſome of ebony, or the like ſcarce and precious woods. Formerly the Dutch and German cabinets were much eſteemed in France; but are now quite out of date, as well as the cabinets of ebony which came from Venice.

Cabinet is alſo uſed in ſpeaking of the more ſelect and ſecret councils of a prince or adminiſtration. Thus we ſay, the ſecrets, the intrigues of the cabinet. To avoid the inconveniences of a numerous council, the policy of Italy and practice of France firſt introduced cabinet councils. King Charles I. is charged with firſt eſtabliſhing this uſuage in England. Beſides his privy council, that prince erected a kind of cabinet council, or junto, under the denomination of a council of ſtate; compoſed of Archbiſhop Laud, the earl of Strafford, and Lord Collington, with the ſecretaries of ſtate. Yet ſome pretend to find the ſubſtance of a cabinet council of much greater antiquity, and even allowed by parliament, which anciently ſettled a quorum of perſons moſt confided in, without whoſe preſence no arduous matter was to be determined; giving them power to act without conſulting the reſt of the council. As long ſince as the 28th of Henry III. a charter paſſed in affirmance of the ancient rights of the kingdom; which provided, that four great men, choſen by common conſent, who were to be converſators of the kingdom, among other things, ſhould ſee to the diſpoſing of moneys given by parliament, and appropriated to particular uſes; and parliaments were to be ſummoned as they ſhould adviſe. But even of theſe four, any two made a quorum: and generally the chief juſtice of England and chancellor were of the number of the conſervators. Matth. Par. 28. Henry III. In the firſt of Henry VI. the parliament provides, that the quorum for the privy council be ſix, or four at leaſt; and that in all weighty conſiderations, the dukes of Bedford and Glouceſter, the king's uncles, ſhould be preſent; which ſeems to be erecting a cabinet by law.

CABIRI, a term in the theology of the ancient Pagans, ſignifying great and powerful gods; being a name given to the gods of Samothracia. They were alſo worſhipped in other parts of Greece, as Lemnos and Thebes, where the cabiria were celebrated in honour of them; theſe gods are ſaid to be in number four, viz. Axieros, Axiocerſa, Axiocerſus, and Caſmilus.

CABIRIA, feſtivals in honour of the Cabiri, celebrated in Thebes and Lemnos, but eſpecially in Samothracia, an iſland conſecrated to the Cabiri. All who were initiated into the myſteries of theſe gods were thought to be ſecured thereby from ſtorms at ſea, and all other dangers. The ceremony of initiation was performed by placing the candidate, crowned with olive branches, and girded about the loins with a purple ribband, on a kind of throne, about which the prieſts and perſons before initiated danced.

CABLE, a thick, large, ſtrong rope, commonly of hemp, which ſerves to keep a ſhip at anchor.

There is no merchant ſhip, however weak, but has at leaſt three cables; namely, the chief cable, or cable of the ſheet anchor, a common cable, and a ſmaller one.

Cable is alſo ſaid of ropes, which ſerve to raiſe heavy loads, by the help of cranes, pulleys, and other engines. The name of *cable* is uſually given to ſuch as are, at leaſt, three inches in circumference; thoſe that are leſs are only called *ropes*, of different names, according to their uſe.

Every cable, of whatſoever thickneſs it be, is compoſed of three ſtrands; every ſtrand of three ropes; and every rope of three twiſts: the twiſt is made of more or leſs threads, according as the cable is to be thicker or thinner.

In the manufacture of cables, after the ropes are made, they uſe ſticks, which they paſs firſt between the ropes of which they make the ſtrands, and afterwards between the ſtrands of which they make the cable, to the end that they may all twiſt the better, and be more regularly wound together; and alſo, to prevent them from entwining or entangling, they hang, at the end of each ſtrand and of each rope, a weight of lead or of ſtone.

The number of threads each cable is compoſed of is always proportioned to its length and thickneſs; and it is by this number of threads that its weight and value are aſcertained: thus, a cable of three inches circumference, or one inch diameter, ought to conſiſt of 48 ordinary threads, and to weigh 192 pounds; and on this foundation is calculated the following table, very uſeful for all people engaged in marine commerce, who fit out merchantmen for their own account, or freight them for the account of others.

A table of the number of threads and weight of cables of different circumferences.

Circumf.	Threads.	Weight.
3 inches.	48	192 pounds.
4	77	308
5 inches	121	484 pounds.
6	174	696
7	238	952
8	311	1244
9	393	1572
10	485	1940
11	598	2392
12	699	2796
13	821	3284
14	952	3808
15	1093	4372
16	1244	4976
17	1404	5616
18	1574	6296
19	1754	7016
20	1943	7772

Sheet-Anchor CABLE, is the greateſt cable belonging to a ſhip.

Stream CABLE, a hawſer or rope, ſomething ſmaller than the bowers, and uſed to moor the ſhip in a river or haven, ſheltered from the wind and ſea, &c.

Serve or *Plate the* CABLE, is to bind it about with ropes, clouts, &c. to keep it from galling in the hawſe.

To Splice a CABLE, is to make two pieces faſt together, by working the ſeveral threads of the rope the one into the other.

Pay more CABLE, is to let more out of the ſhip. *Pay cheap the Cable*, is to hand it out apace. *Veer more Cable*, is to let more out, &c.

CABLE's *Length*, a meaſure of 120 fathoms, or of the uſual length of the cable.

CABLED, in *Heraldry*, a term applied to a croſs formed of the two ends of a ſhip's cable; ſometimes alſo to a croſs covered over with rounds of rope; more properly called a *croſs carded*.

CABLED *Flute*, in *Architecture*, ſuch flutes as are filled up with pieces in the form of a cable.

CABO DE ISTRIA, the capital town of the province of Iſtria, in the territory of Venice; and the ſee of a biſhop. It is ſeated on a ſmall iſland in the gulf of Venice, and is joined to the main land by draw-bridges, E. Long. 14. 22. N. Lat. 45. 49.

CABOCHED, in *Heraldry*, is when the heads of beaſts are borne without any part of the neck, full faced.

CABOLETTO, in commerce, a coin of the republic of Genoa, worth about 3d. of our money.

CABOT, SEBASTIAN, the firſt diſcoverer of the continent of America, was the ſon of John Cabot, a Venetian. He was born at Briſtol in 1477; and was taught by his father, arithmetic, geometry, and coſmography. Before he was 20 years of age he made ſeveral voyages. The firſt of any conſequence ſeems to have been made with his father, who had a commiſſion from Henry VII. for the diſcovery of a north-weſt paſſage to India. They ſailed in the ſpring of 1497; and proceeding to the north-weſt they diſcovered land, which for that reaſon they called *Primaviſta*, or *Newfoundland*. Another ſmaller iſland they called *St John*, from its being diſcovered on the feaſt of St John Baptiſt; after which, they ſailed along the coaſt of America as far as Cape Florida, and then returned to England

land with a good cargo, and three Indians aboard. Stowe and Speed aſcribe theſe diſcoveries wholly to Sebaſtian, without mentioning his father. It is probable that Sebaſtian, after his father's death, made ſeveral voyages to theſe parts, as a map of his diſcoveries, drawn by himſelf, was hung up in the privy garden at Whitehall. However, hiſtory gives but little account of his life for near 20 years: when he went to Spain, where he was made pilot-major, and intruſted with reviewing all projects for diſcoveries, which were then very numerous. His great capacity and approved integrity induced many eminent merchants to treat with him about a voyage by the new found ſtraits of Magellan to the Moluccas. He therefore ſailed in 1525, firſt to the Canaries; then to the Cape de Verd iſlands; thence to St Auguſtine and the iſland of Patos; when ſome of his people beginning to be mutinous, and refuſing to paſs through the ſtraits, he laid aſide the deſign of ſailing to the Moluccas; left ſome of the principal mutineers upon a deſert iſland; and, ſailing up the rivers of Plate and Paraguay, diſcovered, and built forts in, a large tract of fine country, that produced gold, ſilver, and other rich commodities. He thence deſpatched meſſengers to Spain for a ſupply of proviſions, ammunition, goods for trade, and a recruit of men: but his requeſt not being readily complied with, after ſtaying five years in America, he returned home; where he met with a cold reception, the merchants being diſpleaſed at his not having purſued his voyage to the Moluccas, while his treatment of the mutineers had given umbrage at court. Hence he returned to England; and being introduced to the duke of Somerſet, then lord protector, a new office was erected for him: he was made governor of the myſtery and company of the merchant-adventurers for the diſcovery of regions, dominions, iſlands, and places unknown; a penſion was granted him, by letters patent, of 166l. 13s. 4d. per annum; and he was conſulted in all affairs relative to trade. In 1522, by his intereſt, the court fitted out ſome ſhips for the diſcovery of the northern parts of the world. This produced the firſt voyage the Engliſh made to Ruſſia, and the beginning of that commerce which has ever ſince been carried on between the two nations. The Ruſſia company was now founded by a charter granted by Philip and Mary; and of this company Sebaſtian was appointed governor for life. He is ſaid to be the firſt who took notice of the variation of the needle, and who publiſhed a map of the world. The exact time of his death is not known, but he lived to be above 70 years of age.

CABRA, a town of the kingdom of Tombut in Africa. It is a large town, but without walls; and is ſeated on the river Niger, about 12 miles from Tombut. The houſes are built in the ſhape of bells; and the walls are made with ſtakes or hurdles, plaſtered with clay, and covered with reeds after the manner of thatch. This place is very much frequented by negroes who come here by water to trade. The town is very unhealthy, which is probably owing to its low ſituation. The colour of the inhabitants is black, and their religion a ſort of Mahometaniſm. They have plenty of corn, cattle, milk, and butter; but ſalt is very ſcarce. The judge who decides controverſies is appointed by the king of Tombut. E. Long. 0. 50. N. Lat. 14. 21.

CABUL, or GABCUL, a city of Aſia, and capital of the province of Cabuliſtan. It lies in E. Long. 68. 15. N. Lat. 33. 30. on the frontiers of Great Bukharia, on the ſouth ſide of the mountains which divide the territories of the Mogul from that part of Great Tartary. It is one of the fineſt places in that part of the world; large, rich, and very populous. As it is conſidered as the key of the Great Mogul's dominions on that ſide, great care is taken to keep its fortifications in repair, and a numerous garriſon is maintained for its ſecurity. It lies on the road between Samarcand and Lahor; and is much frequented by the Tartars, Perſians, and Indians. The Uſbec Tartars drive there a great trade in ſlaves and horſes, of which it is ſaid that no fewer are ſold than 60,000 annually. The Perſians bring black cattle and ſheep, which renders proviſions very cheap. They have alſo wine, and plenty of all ſorts of eatables. The city ſtands on a little river which falls into the Indus, and thereby affords a ſhort and ſpeedy paſſage for all the rich commodities in the country behind it, which when brought to Cabul, are there exchanged for ſlaves and horſes, and then conveyed by merchants of different countries to all parts of the world. The inhabitants are moſt of them Indian pagans, though the officers of the Mogul and moſt of the garriſon are Mahometans.

CABULISTAN, a province of Aſia, formerly belonging to the Great Mogul; but ceded in 1739 to Kouli Khan, who at that time governed Perſia. It is bounded on the north by Bukharia, on the eaſt by Caſchmire, on the weſt by Zabuliſtan and Candahar, and on the ſouth by Moultan. It is 250 miles in length, 240 in breadth, and its chief town is Cabul. This country in general is not very fruitful; but in the vales they have good paſture lands. The roads are much infeſted with banditti; which obliges the natives to have guards for the ſecurity of travellers. The religion of the Cabuliſtans is pagan; and their extraordinary time of devotion is the full moon in February, and continues for two days. At this time they are clothed in red, make their offerings, dance to the ſound of the trumpet, and make viſits to their friends in maſquerade dreſſes. They ſay, their god Cruſman killed a giant who was his enemy, and that he appeared like a little child; in memory of which, they cauſe a child to ſhoot at the figure of a giant. Thoſe of the ſame tribe make bonfires, and feaſt together in a jovial manner. The moral part of their religion conſiſts in charity; for which reaſon, they dig wells and build houſes for the accommodation of travellers. They have plenty of proviſions, mines of iron, myrobolans, aromatic woods, and drugs of many kinds. They carry on a great trade with the neighbouring countries; by which means they are very rich, and are ſupplied with plenty of all things

CABURNS, on ſhip board, are ſmall lines made of ſpun yarn, to bind cables, ſeize tackles, or the like.

CACALIA. See BOTANY *Index*.

CACAO. See THEOBROMA, BOTANY *Index*.

CACCOONS. See FLEVILLEA, BOTANY *Index*.

CACERES, a town of Spain in the province of Eſtremadura, is ſeated on the river Saler, and noted for the exceeding fine wool which the ſheep bear in the neighbourhood. Between this town and Brocos, there is a wood, where the allies defeated the rear-guard of the duke of Berwick, on the 7th of April 1706. E. Long. 6. 47. N. Lat. 39. 15.

CACHALOT. See Physeter, Cetology *Index*.

CACHAN, or Cashan, a conſiderable town of Perſia, in Irac Agemi, where they carry on an extenſive trade in ſilks, ſilver and gold brocades, and ſine earthen ware. It is ſituated on a vaſt plain, 55 miles from Iſpahan. E. Long. 50. 2. N. Lat. 34. 10.

CACHAO, a province in the kingdom of Tonquin in Aſia, ſituated in the heart of the kingdom, and ſurrounded by the other ſeven. Its ſoil is fertile, and in ſome places mountainous, abounding with a variety of trees, and particularly that of varniſh. Moſt of theſe provinces carry on ſome branch of the ſilk manufacture, but this moſt of all. It takes its name from the capital, which is alſo the metropolis of the whole kingdom, though in other reſpects hardly comparable to a Chineſe town of the third rank.

Cachao, a city of the province of that name, in the kingdom of Tonquin in Aſia, ſituated in E. Long. 105. 31. N. Lat. 22. 10. at about 80 leagues diſtance from the ſea. It is prodigiouſly crowded with people, inſomuch that the ſtreets are hardly paſſable, eſpecially on market days. Theſe vaſt crowds, however, come moſtly from the neighbouring villages; upon which account theſe villages have been allowed their halls in particular parts of the city, where they bring and diſpoſe of their wares. The town itſelf, though the metropolis of the whole Tonquineſe kingdom, hath neither walls nor fortifications. The principal ſtreets are wide and airy, but the reſt of them narrow and ill paved; and except the palace royal and arſenal, the town has little elſe worth notice. The houſes are low and mean, moſtly built of wood and clay, and not above one ſtory high. The magazines and warehouſes belonging to foreigners are the only edifices built of brick: and theſe, though plain, yet, by reaſon of their height and more elegant ſtructure, make a conſiderable ſhow among thoſe rows of wooden huts. From the combuſtibility of its edifices, this city ſuffers frequent and dreadful conflagrations. Theſe ſpread with ſuch ſurpriſing velocity, that ſome thouſands of houſes are often laid in aſhes before the fire can be extinguiſhed. To prevent theſe ſad conſequences, every houſe hath, either in its yard or even in its centre, ſome low building of brick, in form of an oven, into which the inhabitants on the firſt alarm convey their moſt valuable goods. Beſides this precaution, which every family takes to ſecure their goods, the government obliges them to keep a ciſtern, or ſome other capacious veſſel, always full of water on the top of their houſe, to be ready on all occaſions of this nature: as likewiſe a long pole and bucket, to throw water from the kennel upon the houſes. If theſe two expedients fail of ſuppreſſing the flames, they immediately cut the ſtraps which faſten the thatch to the walls, and let it fall in and waſte itſelf on the ground. The king's palace ſtands in the centre of the city; and is ſurrounded with a ſtout wall, within whoſe cincture are ſeen a great number of apartments two ſtories high, whoſe fronts and portals have ſomething of the grand taſte. Thoſe of the king and his wives are embelliſhed with variety of carvings and gildings after the Indian manner, and all finely varniſhed. In the outer court are a vaſt number of ſumptuous ſtables for the king's horſes and elephants. The appearance of the inner courts can only be conjectured; for the avenues are not only ſhut to all ſtrangers, but even to the king's ſubjects, except thoſe of the privy council, and the chief miniſters of ſtate; yet we are told, that there are ſtaircaſes by which people may mount up to the top of the walls, which are about 18 or 20 feet high; from whence they may have a diſtant view of the royal apartments, and of the fine parterres and fiſh ponds that are between the cincture and them. The front wall hath a large gate well ornamented, which is never opened but when the king goes in and out; but at ſome diſtance from it on each ſide there are two poſterns, at which the courtiers and ſervants may go in and out. This cincture, which is of a vaſt circumference, is faced with brick within and without, and the whole ſtructure is terminated by wide ſpacious gardens; which, though ſtored with great variety of proper ornaments, are deſtitute of the grandeur and elegance obſerved in the palaces of European princes. Beſides this palace, the ruins of one ſtill more magnificent are to be obſerved, and are called *Libatvia*. The circumference is ſaid to have been betwixt ſix and ſeven miles; ſome arches, porticoes, and other ornaments are ſtill remaining; from which, and ſome of its courts paved with marble, it may be concluded to have been as magnificent a ſtructure as any of the eaſtern parts can ſhow. The arſenal is likewiſe a large and noble building, well ſtored with ammunition and artillery. The Engliſh factory is ſituated on the north ſide of the city, fronting the river *Song-koy*. It is a handſome low-built houſe, with a ſpacious dining room in the centre; and on each ſide are the apartments of the merchants, factors, and ſervants. At each end of the building are ſmaller houſes for other uſes, as ſtorehouſes, kitchen, &c. which form two wings with the ſquare in the middle, and parallel with the river, near the bank of which ſtands a long flag-ſtaff; on which they commonly diſplay the Engliſh colours on Sundays and all remarkable days. Adjoining to it, on the ſouth ſide, is the Daniſh factory, which is neither ſo large nor ſo handſome. On the ſame ſide of the river runs a long dike, whoſe timber and ſtones are ſo firmly faſtened together, that no part of it can be ſtirred without moving the whole. This work was raiſed on thoſe banks to prevent the river, during the time of their vaſt rains, from overflowing the city; and it has hitherto anſwered its end; for though the town ſtands high enough to be in no danger from land floods, it might yet have been otherwiſe frequently damaged, if not totally laid under water, by the overflowing of that river. Some curious obſervations have been communicated to the Royal Society concerning differences between the tides of thoſe ſeas and thoſe of Europe, viz. that on the Tonquineſe coaſt ebbs and flows but once in 24 hours; that is, that the tide is riſing during the ſpace of 12 hours, and can be eaſily perceived during two of the moon's quarters, but can hardly be obſerved during the other two. In the ſpring tides, which laſt 14 days, the waters begin to riſe at the riſing of the moon; whereas in the low tides, which continue the ſame number of days, the tide begins not till that planet has got below the horizon. Whilſt it is paſſing through the ſix northern ſigns, the tides are obſerved to vary greatly, to riſe ſometimes very high, and ſometimes

times to be very low; but when it is once got into the ſouthern part of the zodiac, they are then found to be more even and regular.

CACHECTIC, ſomething partaking of the nature of, or belonging to, a cachexy.

CACHEO, a town of Negroland in Africa, ſeated on the river St Domingo. It is ſubject to the Portugueſe, who have three ſorts there, and carry on a great trade in wax and ſlaves. W. Long. 14. 65. N. Lat. 12. 0.

CACHEXY, in *Medicine*, a vitious ſtate of the humours and whole habit. See Medicine *Index*.

CACHRYS. See Botany *Index*.

CACHUNDE, the name of a medicine, highly celebrated among the Chineſe and Indians, and made of ſeveral aromatic ingredients, the perfumes, medicinal earth, and precious ſtones: they make the whole into a ſtiff paſte, and form out of it ſeveral figures according to their fancy, which are dried for uſe; theſe are principally uſed in the Eaſt Indies, but are ſometimes brought over to Portugal. In China, the principal perſons uſually carry a ſmall piece in their mouths, which is a continued cordial, and gives their breath a very ſweet ſmell. It is a highly valuable medicine, alſo, in all nervous complaints; and is eſteemed a prolonger of life, and a provocative to venery, the two great intentions of moſt of the medicines in uſe in the Eaſt.

CACOCHYLIA, or Cacochymia, a vitious ſtate of the vital humours, eſpecially of the maſs of blood; ariſing either from a diſorder of the ſecretions or excretions, or from external contagion. The word is Greek, compounded of κακος *ill*, and χυμος *juice*.

CACOPHONIA, in *Grammar* and *Rhetoric*, the meeting of two letters, or ſyllables, which yield an uncouth and diſagreeable ſound. The word is compounded of κακος *evil*, and φωνη *voice*.

Cacophonia, in *Medicine*, denotes a vice or depravation of the voice or ſpeech; of which there are two ſpecies, *aphonia* and *dyſphonia*.

CACTUS. See Botany *Index*.

The cacti are plants of a ſingular ſtructure, but eſpecially the larger kinds of them; which appear like a large, fleſhy, green melon, with deep ribs, ſet all over with ſtrong ſharp thorns, and, when the plants are cut through the middle, their inſide is a ſoft, pale-green, fleſhy ſubſtance, very full of moiſture. The fruit of all the ſpecies is frequently eaten by the inhabitants of the Weſt Indies. The fruits are about three quarters of an inch in length, of a taper form, drawing to a point at the bottom toward the plant, but blunt at the top where the empalement of the flower was ſituated. The taſte is agreeably acid, which in a hot country muſt render the fruit more grateful.

The cochineal animals are ſupported on a ſpecies called *cactus cochenillifer*.—The flower of the cactus grandiflora (one of the creeping cereuſes) is ſaid to be as grand and beautiful as any in the vegetable ſyſtem: It begins to open in the evening about ſeven o'clock, is in perfection about eleven, and fades about four in the morning; ſo that the ſame flower only continues in perfection about ſix hours. The calyx when expanded is about a foot in diameter, of a ſplendid yellow within, and a dark brown without, the petals are many, and of a pure white; and the great number of recurved ſtamina, ſurrounding the ſtyle in the centre of the flower, make a grand appearance, to which may be added the fine ſcent, which perfumes the air to a conſiderable diſtance. It flowers in July.

CACUS, in fabulous hiſtory, an Italian ſhepherd upon Mount Aventine. As Hercules was driving home the herd of King Geryon whom he had ſlain, Cacus robbed him of ſome of his oxen, which he drew backward into his den leſt they ſhould be diſcovered. Hercules at laſt finding them out by their lowing, or the robbery being diſcovered to him, killed Cacus with his club. He was Vulcan's ſon, of prodigious bulk, and half man half ſatyr.

CADAN, a town of Bohemia, in the circle of Zats, ſeated on the northern bank of the river Egra, in E. Long. 13. 34. N. Lat. 50. 20.

CADARI, or Kadari, a ſect of Mahometans, who aſſert free will; attribute the actions of men to men alone, not to any ſecret power determining the will; and deny all abſolute decrees, and predeſtination. The author of this ſect was Mabeb ben Kaled al Gihoni, who ſuffered martyrdom for it. The word comes from the Arabic, קדר, *cadara*, "power." Ben Aun calls the Cadarians the Magi or Manichees of the Muſſelmans.

CADE, a cag, caſk or barrel. A cade of herrings is a veſſel containing the quantity of 500 red herrings, or 1000 ſprats.

Cade Lamb, a young lamb weaned, and brought up by hand, in a houſe; called, in the North, *pet lamb*.

Cade Oil, in the *Materia Medica*, a name given to an oil much in uſe in ſome parts of France and Germany. The phyſicians call it *oleum cadæ*, or *oleum de cada*. This is ſuppoſed by ſome to be the piſſelæum of the ancients, but improperly; it is made of the fruit of the oxycedrus, which is called by the people of theſe places *cada*.

Cade Worm, in *Zoology*, the maggot or worm of a fly called *phryganea*. It is uſed as a bait in angling. See Phryganea, Entomology *Index*.

CADEA, or the league of the house of God, is one of thoſe that compoſe the republic of the Griſons, and the moſt powerful and extenſive of them all. It contains the biſhopric of Coire, the great valley of Engadine, and that of Bragail or Pregal. Of the 11 great, or 21 ſmall communities, there are but two that ſpeak the German language; that of the reſt is called the *Rhetic*, and is a dialect of the Italian. The Proteſtant religion is moſt prevalent in this league, which has been allied to the Swiſs cantons ever ſince the year 1498. Coire is the capital town.

CADENAC, a town of France, in Querci, on the confines of Rouergue, ſeated on the river Lot, in E. Long. 2. 12. N. Lat. 44. 36.

CADENCE, or Repose, in *Muſic*, (from the Latin *cadere* "to fall or deſcend"); the termination of an harmonical phraſe on a repoſe, or on a perfect chord. See Music, Art. 73—76, and 132—137.

Cadence, in *Reading*, is a falling of the voice below the key note at the cloſe of every period. In reading, whether proſe or verſe, a certain tone is aſſumed which is called the *key note*; and in this tone the bulk of the words are ſounded: but this note is generally lowered towards the cloſe of every ſentence.

CADENCE, in the manege, an equal meaſure or proportion, obſerved by a horſe in all his motions; ſo that his times have an equal regard to one another, the one does not embrace or take in more ground than the other, and the horſe obſerves his ground regularly.

CADENE, one of the ſorts of carpets which the Europeans import from the Levant. They are the worſt ſort of all, and are ſold by the piece from one to two piaſtres per carpet.

CADENET, a town of France in Provence, and in the vigurie of Apt. E. Long. 5. 30. Lat. 43. 40.

CADES, or KADESH, in *Ancient Geography*, a town in the wilderneſs of Zin, in Arabia Petræa; the firſt encampment of the Iſraelites, after their departure from Eziongeber; and from which the wilderneſs of Zin was called Cades; the burial place of Miriam, with the rock and water of Meribah in it. Another *Cades*, a town of the tribe of Judah, Joſhua xv. 23. *Cadeſbarnea*, called alſo *Cades*.

CADESBARNEA, in *Ancient Geography*, a town of the wilderneſs of Paran, on the confines of Canaan, from which the ſpies were ſent out; ſometimes ſimply called *Cades*, but diſtinct from the Cades in the wilderneſs of Zin.

CADET, the younger ſon of a family, is a term naturalized in our language from the French. At Paris, among the citizens, the cadets have an equal patrimony with the reſt. At Caux, in Normandy, the cuſtom, as with us, is to leave all to the eldeſt, except a ſmall portion to the cadets. In Spain, it is uſual for one of the cadets in great families to take the mother's name.

CADET is alſo a military term, denoting a young gentleman who chooſes to carry arms in a marching regiment as a private man. His views are, to acquire ſome knowledge in the art of war, and to obtain a commiſſion in the army. Cadet differs from volunteer, as the former takes pay, whereas the latter ſerves without pay.

CADI, or CADHI, a judge of civil affairs in the Turkiſh empire. It is generally taken for the judge of a town; judges of provinces being diſtinguiſhed by the appellation of *mollas*.

We find numerous complaints of the avarice, iniquity, and extortion, of the Turkiſh cadis; all juſtice is here venal; the people bribe the cadis, the cadis bribe the moulas, the moulas the cadileſchers, and the cadileſchers the mufti. Each cadi has his ſerjeants, who are to ſummon perſons to appear and anſwer complaints. If the party ſummoned fails to appear at the hour appointed, ſentence is paſſed in favour of his adverſary. It is uſually vain to appeal from the ſentences of the cadi, ſince the affair is never heard anew, but judgment is paſſed on the caſe as ſtated by the cadi. But the cadis are often caſhiered and puniſhed for crying injuſtice with the baſtinado and mulcts; the law, however, does not allow them to be put to death. Conſtantinople has had cadis ever ſince the year 1390, when Bajazet I. obliged John Paleologus, emperor of the Greeks, to receive cadis into the city to judge all controverſies happening between the Greeks and the Turks ſettled there. In ſome countries of Africa, the cadis are alſo judges of religious matters. Among the Moors cadis is the denomination of their higher order of prieſts or doctors, anſwering to the rabbins among the Jews.

CADIACI, the Turkiſh name of Chalcedon. See CHALCEDON.

CADILESCHER, a capital officer of juſtice among the Turks, anſwering to a chief juſtice among us.

It is ſaid, that this authority was originally confined to the ſoldiery; but that, at preſent, it extends itſelf to the determination of all kinds of law-ſuits; yet is nevertheleſs ſubject to appeals.

There are but three cadileſchers in all the grand ſignior's territories; the firſt is that of Europe; the ſecond, of Natolia; and the third reſides at Grand Cairo. This laſt is the moſt conſiderable: they have their ſeats in the divan next to the grand vizir.

CADILLAC, a town of France in Guienne, and in Bazadois, near the river Garonne, with a handſome caſtle, ſituated in W. Long. 0. 15. N. Lat. 44. 37.

CADIZ, a city and port town of Andaluſia in Spain, ſituated on the iſland of Leon, oppoſite to Port St Mary on the continent, about 60 miles ſouth-weſt of Seville, and 40 north-weſt of Gibraltar. W. Long. 6. 40. N. Lat. 36. 30.

It occupies the whole ſurface of the weſtern extremity of the iſland, which is compoſed of two large circular parts, joined together by a very narrow bank of ſand, forming altogether the figure of a chain-ſhot. At the ſouth-eaſt end, the ancient bridge of Suaco, thrown over a deep channel or river, affords a communication between the iſland and the continent; a ſtrong line of works defends the city from all approaches along the iſthmus; and, to render them ſtill more difficult, all the gardens and little villas on the beach were in 1762 cleared away, and a dreary ſandy glacis left in their room, ſo that now there is ſcarce a tree on the whole iſland.

Except the *Calle Ancha*, all the ſtreets are narrow, ill paved, and inſufferably ſtinking. They are all drawn in ſtraight lines, and moſt of them interſect each other at right angles. The ſwarms of rats that in the nights run about the ſtreets are innumerable; whole droves of them paſs and repaſs continually, and theſe their midnight revels are extremely troubleſome to ſuch as walk late. The houſes are lofty, with each a veſtibule, which being left open till night, ſerves paſſengers to retire to; this cuſtom, which prevails throughout Spain, renders theſe places exceedingly offenſive. In the middle of the houſe is a court like a deep well, under which is generally a ciſtern, the breeding place of gnats and moſquitos; the ground floors are warehouſes, the firſt ſtories compting-houſe or kitchen, and the principal apartment up two pair of ſtairs. The roofs are flat, covered with an impenetrable cement, and few are without a *mirador* or turret for the purpoſe of commanding a view of the ſea. Round the parapet-wall at top are placed rows of ſquare pillars, meant either for ornament, according to ſome traditional mode of decoration, or to fix awnings to, that ſuch as ſit there for the benefit of the ſea breeze may be ſheltered from the rays of the ſun; but the moſt common uſe made of them, is to faſten ropes for drying linen upon. High above all theſe pinnacles, which give Cadiz a moſt ſingular appearance, ſtands the tower of ſignals. Here flags are hung out on the firſt ſight of a ſail, marking the ſize of the ſhip, the nation it belongs to, and if a Spaniſh Indiamen, the port of the Indies it comes from. The ſhips are acquainted with the proper ſignals to be made, and theſe are repeated by the watchmen of the tower: as painted liſts are in every houſe, perſons concerned in commerce ſoon learn the marks.

The city is divided into 24 quarters, under the inſpection of as many commiſſioners of police; and its population is reckoned at 140,000 inhabitants, of which 12,000 are French, and at leaſt as many more Italians. The ſquare of Saint Antonia is large, and tolerably handſome, and there are a few ſmaller openings of no great note. The public walk, or Alameda, is pleaſant in the evening: it is fenced off the coach road by a marble rail. The ſea air prevents the trees from thriving, and deſtroys all hopes of future ſhade.

From the Alameda, continuing your walk weſtwards, you come to the Campoſanto, a large eſplanade, the only airing-place for coaches; it turns round moſt part of the weſt and ſouth ſides of the iſland, but the buildings are ſtraggling and ugly; the only edifice of any ſhow is the new orphan houſe; oppoſite to it is the fortreſs of St Sebaſtian, built on a neck of land running out into the ſea. The round tower at the extremity is ſuppoſed to have ſaved the city, in the great earthquake of 1755, from being ſwept away by the fury of the waves. The building proved ſufficiently ſolid to withſtand the ſhock, and break the immenſe volume of water that threatened deſtruction to the whole iſland. In the narrow part of the iſthmus the ſurge beat over with amazing impetuoſity, and bore down all before it; among the reſt, the grandſon of the famous tragic poet Racine, who ſtrove in vain to eſcape, by urging his horſe to the utmoſt of his ſpeed. On St Sebaſtian's feaſt, a kind of wake or fair is held in the fort; an aſtoniſhing number of people then paſſing and repaſſing, on a ſtring of wooden bridges laid from rock to rock, makes a very lively moving picture.

From hence to the wooden circus where they exhibit the bull feaſts, you keep turning to the left cloſe above the ſea, which on all this ſide daſhes over large ledges of rock: the ſhore ſeems here abſolutely inacceſſible. On this ſhore ſtands the cathedral, a work of great expence, but carried on with ſo little vigour, that it is difficult to gueſs at the term of years it will require to bring it to perfection. The vaults are executed with great ſolidity. The arches, that ſpring from the cluſtered pilaſters to ſupport the roof of the church, are very bold; the minute ſculpture beſtowed upon them ſeems ſuperfluous, as all the effect will be loſt from their great height, and from the ſhade that will be thrown upon them by the filling up of the interſtices. From the ſea, the preſent top of the church reſembles the carcaſe of ſome huge monſter caſt upon its ſide, rearing its gigantic blanched ribs high above the buildings of the city. The outward caſings are to be of white marble, the bars of the windows of bronze.

Next, croſſing before the land gate and barracks, a ſuperb edifice for ſtrength, convenience, and cleanlineſs, you come down to the ramparts that defend the city on the ſide of the bay. If the proſpect to the ocean is ſolemn, that towards the main land is animated in the higheſt degree; the men of war ride in the eaſtern boſom of the bay; lower down the merchantmen are ſpread far and near; and cloſe to the town an incredible number of barks, of various ſhapes and ſizes, cover the ſurface of the water, ſome moored and ſome in motion, carrying goods to and fro. The oppoſite ſhore of Spain is ſtudded with white houſes, and enlivened by the towns of St Mary's, Port-real, and others, behind which, eaſtward, on a ridge of hills, ſtands Medina Sidonia, and further back riſe the mountains of Granada. Weſtward, Rota cloſes the horizon, near which was anciently the iſland and city of Tarteſſus, now covered by the ſea, but at low water ſome part of the ruins are ſtill to be diſcerned. In a large baſtion, jutting out into the bay, they have built the cuſtom-houſe, the firſt ſtory of which is level with the walk upon the walls. When it was reſolved to erect a building ſo neceſſary to this great emporium of trade, the marquis di Squillace gave orders that no expence ſhould be ſpared, and the moſt intelligent architects employed, in order to erect a monument, which by its taſte and magnificence might excite the admiration of poſterity: the reſult of theſe precautions proved a piece of vile architecture, compoſed of the worſt of materials.

The ſtir here is prodigious during the laſt months of the ſtay of the flota. The packers poſſeſs the art of preſſing goods to great perfection; but, as they pay the freight according to the cubic palms of each bale, they are apt to ſqueeze down the cloths and linens ſo very cloſe and hard, as ſometimes to render them unfit for uſe. The exportation of French luxuries in dreſs is enormous; Lyons furniſhes moſt of them; England ſends out bale goods; Brittany and the north linens. Every commercial nation has a conſul reſident at Cadiz; thoſe of England and France are the only ones not allowed to have any concern in trade.

In 1596, Cadiz was taken, pillaged, and burnt by the Engliſh; but in 1702 it was attempted in conjunction with the Dutch, without ſucceſs.

CADIZADELITES, a ſect of Mahometans very like the ancient Stoics. They ſhun feaſts and diverſions, and affect an extraordinary gravity in all their actions; they are continually talking of God, and ſome of them make a jumble of Chriſtianity and Mahometaniſm; they drink wine, even in the faſt of the Ramazan; they love and protect the Chriſtians; they believe that Mahomet is the Holy Ghoſt, practiſe circumciſion, and juſtify it by the example of Jeſus Chriſt.

CADMEAN LETTERS, the ancient Greek or Ionic characters, ſuch as they were firſt brought by Cadmus from Phœnicia; whence Herodotus alſo calls them *Phœnician letters*. According to ſome writers, Cadmus was not the inventor, nor even importer of the Greek letters, but only the modeller and reformer thereof; and it was hence they acquired the appellation *Cadmean* or *Phœnician letters*; whereas before that time they had been called *Pelaſgian letters*.

CADMIA. See CALAMINE.

CADMUS, in fabulous hiſtory, king of Thebes, the ſon of Agenor king of Phœnicia, and the brother of Phœnix, Cilix, and Europa. He carried into Greece the 16 ſimple letters of the Greek alphabet; and there built Thebes, in Bœotia. The poets ſay, that he left his native country in ſearch of his ſiſter Europa, whom Jupiter had carried away in the form of a bull: and that, inquiring of the Delphic oracle for a ſettlement, he was anſwered, that he ſhould follow the direction of a cow, and build a city where ſhe lay down. Having arrived among the Phocenſes, he was met by a cow, who conducted him through Bœotia to the place where Thebes was afterwards built: but as he was about to ſacrifice his guide to Pallas, he ſent two of his company to the fountain Dirce for water; when they being devoured by a ſerpent or dragon, he ſlew the monſter, and afterwards, by the advice of Pallas, ſowed his teeth, when there ſprung up a number of armed ſoldiers, who prepared to revenge the death of the ſerpent; but on his caſting a ſtone among theſe upſtart warriors, they turned their weapons againſt each other with ſuch animoſity, that only five ſurvived the combat, and theſe aſſiſted Cadmus in founding his new city. Afterwards, to recompenſe his labours, the gods gave him Harmonia, or Harmione, the daughter of Mars and Venus; and honoured his nuptials with preſents and peculiar marks of favour. But at length reſigning Thebes to Pentheus, Cadmus and Harmione went to govern the Ecclellenſes: when grown old, they were tranſformed into ſerpents; or, as others ſay, ſent to the Elyſian fields, in a chariot drawn by ſerpents. See THEBES.

CADMUS of Miletus, a celebrated Greek hiſtorian, was, according to Pliny, the firſt of the Greeks who wrote hiſtory in proſe. He flouriſhed about 550 before Chriſt.

CADORE, or PIEVE DE CADORE, a town of Italy, in the territory of Venice, and capital of a diſtrict called *Cadorino*; famous for the birth of Titian the painter. E. Long. 13. 45. N. Lat. 46. 25.

CADORINO, a province of Italy, in the territory of Venice; bounded on the eaſt by Friuli Proper, on the ſouth and weſt by the Belluneſe, and by the biſhopric of Brixen on the north. It is a very mountainous country, but pretty populous. The only town is Pieve de Cadore.

CADRITES, a ſort of Mahometan friars, who once a-week ſpend a great part of the night in turning round, holding each others hands, and repeating inceſſantly the word *hai*, which ſignifies *living*, and is one of the attributes of God; during which one of them plays on a flute. They never cut their hair, nor cover their heads; and always go bare-footed: they have liberty to quit their convent when they pleaſe, and to marry.

CADSAND, an iſland on the coaſt of Dutch Flanders, ſituated at the mouth of the Scheldt, whereby the Dutch command the navigation of that river.

CADUCEUS, in antiquity, Mercury's rod or ſceptre, being a wand entwiſted by two ſerpents, borne by that deity as the enſign of his quality and office, giving him, according to the fable, by Apollo, for his ſeven-ſtringed harp. Wonderful properties are aſcribed to this rod by the poets; as laying men aſleep, raiſing the dead, &c.

It was alſo uſed by the ancients as a ſymbol of peace and concord: the Romans ſent the Carthaginians a javelin and a caduceus, offering them their choice either of war or peace. Among that people, thoſe who denounced war were called *feciales*; and thoſe who went to demand peace, *caduceatores*, becauſe they bore a caduceus in their hand.

The caduceus found on medals is a common ſymbol, ſignifying good conduct, peace and proſperity. The rod expreſſes power, the two ſerpents prudence, and the two wings diligence.

CADUCI, (from *cado* "to fall"); the name of a claſs in Linnæus's *calycina*, conſiſting of plants whoſe calyx is a ſimple perianthium, ſupporting a ſingle flower or fructification, and falling off either before or with the petals. It ſtands oppoſed to the *claſſes perſiſtentes* in the ſame method, and is exemplified in muſtard and ranunculus.

CADURCI, CADURCUM, *Cadurcus* and *Cadurx*, in *Ancient Geography*, a town of the Cadurci, a people of Aquitania; ſituated between the rivers Oldus, running from the north, and the Tarnis from the ſouth, and falling into the Garumna: Now *Cahors*, capital of the territory of the Querci, in Guienne. A part of the Cadurci, to the ſouth next the Tarnis, were called *Eleutheri*.

CADUS, in antiquity, a wine veſſel of a certain capacity, containing 80 amphoræ or firkins; each of which, according to the beſt accounts, held nine gallons.

CADUSII, in *Ancient Geography*, a people of Media Atropatene, ſituated to the weſt in the mountains, and reaching to the Caſpian ſea; between whom and the Medes perpetual war and enmity continued down to the time of Cyrus.

CÆCILIA, in *Zoology*, a genus of ſerpents belonging to the amphibia claſs. The cæcilia has no ſcales; it is ſmooth, and moves by means of lateral rugæ or prickles. The upper lip is prominent, and furniſhed with two tentacula. It has no tail. There are but two ſpecies of this ſerpent, viz. 1. The tentaculata, has 135 rugæ. It is about a foot long, and an inch in circumference, preſerving an uniform cylindrical ſhape from the one end to the other. The teeth are very ſmall. It has ſuch a reſemblance to an eel, that it may eaſily be miſtaken for one; but as it has neither fins nor gills, it cannot be claſſed with the fiſhes. It is a native of America, and its bite is not poiſonous. 2. The glutinoſa, has 340 rugæ or prickles above, and 10 below, the anus. It is of a browniſh colour, with a white line on the ſide, and is a native of the Indies.

CÆCUM, or COECUM, the blind gut. See ANATOMY *Index*.

CÆLIUM, in *Ancient Geography*, an inland town of Peucetia, a diviſion of Apulia; a place four or five miles above Barium or Bari, and which ſtill retains that name.

CÆLIUS MONS, (Itinerary); a town of Vindelicia, on the right or weſt ſide of the Ilargus. Now *Kelmuntz*, a ſmall town of Suabia, on the Iller.

CÆLIUS MONS at Rome. See COELIUS.

CÆLIUS, *Aurelianus*, an ancient phyſician, and the only one of the ſect of the Methodiſts of whom we have any remains. He was of Sicca, a town of Numidia; but in what age he lived, cannot be determined: it is probable, however, that he lived before Galen: ſince, though he carefully mentions all the phyſicians before him, he takes no notice of Galen. He had read over very diligently the ancient phyſicians of all ſects; and we are indebted to him for the knowledge of many dogmas which are not to be found but in his books *de celeribus et tardis paſſionibus.* He wrote, as he himſelf tells us, ſeveral other works; but they are all periſhed.

CAEN, a handſome and conſiderable town of France, capital of Lower Normandy, with a celebrated univerſity, and an academy of literature. It contains 60 ſtreets, and 12 pariſhes. It has a caſtle with four towers, which were built by the Engliſh. The town-houſe is a large building with four great towers. The royal ſquare is the handſomeſt in all Normandy, and has fine houſes on three ſides of it; and in the middle is the ſtatue of Louis XIV. in a Roman habit, ſtanding on a marble pedeſtal, and ſurrounded with an iron balluſtrade. It is ſeated in a pleaſant country, on the river Orne, about eight miles from the ſea. William the Conqueror was buried here, in the abbey of St Stephen, which he founded. W. Long. 0. 27. N. Lat. 49. 11.

CÆRE, in *Ancient Geography*, a town of Etruria, the royal reſidence of Mezentius. Its ancient name was *Argyllæ*. In Strabo's time not the leaſt veſtige of it remained, except the baths called *cæretana*. From this town the Roman cenſor's tables were called *cærites tabulæ*. In theſe were entered the names of ſuch as for ſome miſdemeanor forfeited their right of ſuffrage, or were degraded from a higher to a leſs honourable tribe. For the people of Cære hoſpitably receiving thoſe Romans who, after the taking of Rome by the Gauls, fled with their gods and the ſacred fire of Veſta, were, on the Romans recovering themſelves from this diſaſter, honoured with the privilege of the city, but without a right of voting.

CÆRITES TABULÆ. See the preceding article.

CAERFILLY, a town of Glamorganſhire, in South Wales, ſeated between the rivers Taaff and Rumney, in a mooriſh ground among the hills. It is thought the walls, now in ruins, were built by the Romans; there being often Roman coins dug up there. W. Long. 3. 12. N Lat. 51. 25.

CAERLEON, a town of Monmouthſhire in England, and a place of great antiquity. It was a Roman town, as is evident from the many Roman antiquities found here. It is commodiouſly ſituated on the river Uſk, over which there is a large wooden bridge. The houſes are generally built of ſtone, and there are the ruins of a caſtle ſtill to be ſeen. W. Long. 3. 0. N. Lat. 51. 40.

CAERMARTHEN-SHIRE, a county of Wales, bounded on the north by the Severn ſea or St George's channel, Cardiganſhire on the ſouth, the ſhires of Brecknock and Glamorgan on the eaſt, and Pembrokeſhire on the weſt. Its greateſt length is between 30 and 40 miles, and its breadth upwards of 20. The air is wholeſome, and the ſoil leſs rocky and mountainous than moſt other parts of Wales, and conſequently is proportionally more fertile both in corn and paſture. It has alſo plenty of wood, and is well ſupplied with coal and limeſtone. The moſt conſiderable rivers are the Towy, the Cothy, and the Tave; of which, the firſt abounds with excellent ſalmon. The principal towns are Caermarthen, the capital, Kidwely, Lanimdovery, &c. This county abounds with ancient forts, camps, and tumuli or barrows. Near to Caermarthen, towards the eaſt, may be ſeen the ruins of Kaſtelk Karrey, which was ſituated on a ſteep and inacceſſible rock; and alſo ſeveral vaſt caverns, ſuppoſed to have been copper mines of the Romans. Near this ſpot is a fountain which ebbs and flows twice in 24 hours like the ſea.

CAERMARTHEN, a town of Wales, and capital of the county of that name. It is ſituated on the river Fowey, over which it has a fine ſtone bridge. It is of great antiquity, being the Maridunum of Ptolemy. It is a populous, thriving, and polite place, many of the neighbouring gentry reſiding there in the winter. It is a corporation and county of itſelf, with power to make by-laws. Here were held the courts of chancery and exchequer for South Wales, till the whole was united to England in the reign of Henry VIII. Here was born the famous conjurer Merlin; and near the town is a wood called *Merlin's grove*, where he is ſaid to have often retired for contemplation. Many of his pretended prophecies are ſtill preſerved in the country. The town gives the title of *marquis* to his grace the duke of Leeds. It ſends one member to parliament, and the county another.

CAERNARVON-SHIRE, a county of Wales, bounded on the north and weſt by the ſea, on the ſouth by Merionethſhire, and on the eaſt is divided from Denbighſhire by the river Conway. It is about 40 miles in length, and 20 in breadth; and ſends one member to parliament for the ſhire, and another for the borough of Caernarvon. The air is very piercing; owing partly to the ſnow, that lies ſeven or eight months of the year upon ſome of the mountains, which are ſo high that they are called the *Britiſh Alps;* and partly to the great number of lakes, which are ſaid not to be fewer than 50 or 60. The ſoil in the valleys on the ſide next Ireland is pretty fertile, eſpecially in barley; great numbers of black cattle, ſheep, and goats, are fed on the mountains: and the ſea, lakes, and rivers, abound with variety of fiſh. The higheſt mountains in the county are thoſe called *Snowdon hills*, and *Pen-maen-mawr*, which laſt hangs over the ſea. There is a road cut out of the rock on the ſide next the ſea, guarded by a wall running along the edge of it on that ſide; but the traveller is ſometimes in danger of being cruſhed by the fall of pieces of the rock from the precipices above. The river Conway, though its courſe from the lake out of which it iſſues to its mouth is only 12 miles, yet is ſo deep, in conſequence of the many brooks it receives, that it is navigable by ſhips of good burden for eight miles. Pearls are found in large black muſcles taken in this river. The principal towns are Bangor, Caernarvon the capital, and Conway. In this county is an ancient road ſaid to have been made by Helena the mother of Conſtantine the Great; and Matthew of Weſtminſter aſſerts, that the body of Conſtantius the father of the ſame Conſtantine, was found at Caernarvon in the year 1283, and interred in the pariſh church there by order of Edward I.

CAERNARVON, a town of Wales, and capital of the county of that name. It was built by Edward I. near the ſite of the ancient Segontium, after his conqueſt of the country in 1282, the ſituation being well adapted to overawe his new ſubjects. It had natural requiſites for ſtrength; being bounded on one ſide by the arm of the ſea called the *Menai;* by the eſtuary of the

Sciont on another, exactly where it receives the tide from the former; on a third ſide, and a part of the fourth, by a cheek of the Menai; and the remainder has the appearance of having the inſulation completed by art. Edward undertook this great work immediately after his conqueſt of the country in 1282, and completed the fortifications and caſtle before 1284; for his queen, on April 25th in that year, brought forth within its walls Edward, firſt prince of Wales of the Engliſh line. It was built within the ſpace of one year, by the labour of the peaſants, and at the coſt of the chieftans of the country, on whom the conqueror impoſed the hateful taſk. The external ſtate of the walls and caſtle, Mr Pennant informs us, are at preſent exactly as they were in the time of Edward. The walls are defended by numbers of round towers, and have two principal gates: the eaſt, facing the mountains; the weſt, upon the Menai. The entrance into the caſtle is very auguſt, beneath a great tower, on the front of which appears the ſtatue of the founder, with a dagger in his hand, as if menacing his new acquired unwilling ſubjects. The gate had four portculliſes, and every requiſite of ſtrength. The towers are very beautiful. The eagle tower is remarkably fine, and has the addition of three ſlender angular turrets iſſuing from the top. Edward II. was born in a little dark room in this tower, not twelve feet long nor eight in breadth: ſo little did, in thoſe days, a royal conſort conſult either pomp or conveniency. The gate through which the affectionate Eleanor entered, to give the Welſh a prince of their own, who could not ſpeak a word of Engliſh, is at the fartheſt end, at a vaſt height above the outſide ground; ſo could only be approached by a drawbridge. The quay is a moſt beautiful walk along the ſide of the Menai, and commands a moſt agreeable view.

Caernarvon is deſtitute of manufactures, but has a briſk trade with London, Briſtol, Liverpool, and Ireland, for the ſeveral neceſſaries of life. It is the reſidence of numbers of genteel families, and contains ſeveral very good houſes. Edward I. beſtowed on this town its firſt royal charter, and made it a free borough. Among other privileges, none of the burgeſſes could be convicted of any crime committed between the rivers Conway and Dyfe, unleſs by a jury of their own townſmen. It is governed by a mayor, who, by patent, is created governor of the caſtle. It has one alderman, two bailiffs, a town clerk, and two ſerjeants at mace. The repreſentative of the place is elected by its burgeſſes, and thoſe of Conway, Pwllheli, Neſyn, and Crickaeth. The right of voting is in every one, reſident or non-reſident, admitted to their freedom. The town gives title of *earl* and *marquis* to the duke of Chandos, and has a good tide harbour.

CAERWIS, a market town of Flintſhire, in North Wales, ſituated in W. Long. 3. 25. N. Lat 53. 20.

CÆSALPINIA Brasiletto, or *Braſil wood.* See Botany *Index.* Of this there are three ſpecies, the moſt remarkable of which is the braſilienſis, commonly called *Braſiletto.* It grows naturally in the warmeſt parts of America, from whence the wood is imported for the dyers, who uſe it much. The demand has been ſo great, that none of the large trees are left in any of the Britiſh plantations; ſo that Mr Cateſby owns himſelf ignorant of the dimenſions to which they grow. The largeſt remaining are not above two inches in thickneſs, and eight or nine feet in height. The branches are ſlender and full of ſmall prickles; the leaves are pinnated; the lobes growing oppoſite to one another, broad at their ends, with one notch. The flowers are white, papilionaceous, with many ſtamina and yellow apices, growing in a pyramidal ſpike, at the end of a long ſlender ſtalk: the pods encloſe ſeveral ſmall round ſeeds. The colour produced from this wood is greatly improved by ſolution of tin in aqua regia *. The ſecond ſort is a native of the ſame countries with the firſt, but is of a larger ſize. It ſends out many weak irregular branches, armed with ſhort, ſtrong, upright thorns. The leaves branch out in the ſame manner as the firſt; but the lobes, or ſmall leaves, are oval and entire. The flowers are produced in long ſpikes like thoſe of the former, but are variegated with red. Theſe plants may be propagated from ſeeds, which ſhould be ſown in ſmall pots filled with light rich earth early in the ſpring, and plunged in a bed of tanner's bark. Being tender, they require to be always kept in the ſtove, and to be treated in the ſame manner as other exotics of that kind.

CÆSALPINUS, of Arezzo, profeſſor at Piſa, and afterwards phyſician to Pope Clement VIII. one of the capital writers in botany. See Botany *Index.*

CÆSAR, Julius, the illuſtrious Roman general and hiſtorian, was of the family of the Julii, who pretended they were deſcended from Venus by Æneas. The deſcendants of Aſcanius, ſon of Æneas and Creuſa, and ſurnamed *Julius,* lived in Alba till that city was ruined by Tullus Hoſtilius king of Rome, who carried them to Rome, where they flouriſhed. We do not find that they produced more than two branches. The firſt bore the name of *Tullus,* the other that of *Cæſar.* The moſt ancient of the Cæſars were thoſe who were in public employments in the 11th year of the firſt Punic war. After that time we find there was always ſome of that family who enjoyed public offices in the commonwealth, till the time of Caius Julius Cæſar, the ſubject of this article. He was born at Rome the 12th of the month Quintilis, year of the city 653, and loſt his father an. 669. By his valour and eloquence he ſoon acquired the higheſt reputation in the field and in the ſenate. Beloved and reſpected by his fellow citizens, he enjoyed ſucceſſively every magiſterial and military honour the public could beſtow conſiſtent with its own free conſtitution. But at length having ſubdued Pompey the great rival of his growing power, his boundleſs ambition effaced the glory of his former actions: for, purſuing his favourite maxim, "that he had rather be the firſt man in a village than the ſecond in Rome," he procured himſelf to be choſen perpetual dictator; and, not content with this unconſtitutional power, his faction had reſolved to raiſe him to the imperial dignity; when the friends of the civil liberties of the republic raſhly aſſaſſinated him in the ſenate-houſe, where they ſhould only have ſeized him and brought him to a legal trial for uſurpation. By this impolitic meaſure they defeated their own purpoſe, involving the city in conſternation and terror, which produced general anarchy, and paved the way to the revolution they wanted to prevent; the monarchial government being abſolutely founded on the murder of Julius Cæſar. He fell in the 56th year of his age, 43 years before the Chriſtian era. His commentaries contain a hiſtory of his principal voyages, battles, and victories. The London edition in 1712, in folio, is preferred.

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* See Colour-making and Dyeing.

The detail of Cæſar's tranſactions (ſo far as is conſiſtent with the limits of this work) being given under the article Rome, we ſhall here only add a portrait of him as drawn by a philoſopher*.

" If, after the lapſe of 18 centuries, the truth may be publiſhed without offence, a philoſopher might, in the following terms, cenſure Cæſar without calumniating him, and applaud him without exciting his bluſhes.

" Cæſar had one predominant paſſion: it was the love of glory; and he paſſed 40 years of his life in ſeeking opportunities to foſter and encourage it. His ſoul, entirely abſorbed in ambition, did not open itſelf to other impulſes. He cultivated letters; but he did not love them with enthuſiaſm, becauſe he had not leiſure to become the firſt orator of Rome. He corrupted the one half of the Roman ladies, but his heart had no concern in the fiery ardours of his ſenſes. In the arms of Cleopatra, he thought of Pompey; and this ſingular man, who diſdained to have a partner in the empire of the world, would have bluſhed to have been for one inſtant the ſlave of a woman.

" We muſt not imagine, that Cæſar was born a warrior, as Sophocles and Milton were born poets. For, if nature had made him a citizen of Sybaris, he would have been the moſt voluptuous of men. If in our days he had been born in Pennſylvania, he would have been the moſt inoffenſive of Quakers, and would not have diſturbed the tranquillity of the new world.

" The moderation with which he conducted himſelf after his victories, has been highly extolled; but in this he ſhowed his penetration, not the goodneſs of his heart. Is it not obvious, that the diſplay of certain virtues is neceſſary to put in motion the political machine? It was requiſite that he ſhould have the appearance of clemency, if he inclined that Rome ſhould forgive him his victories. But what greatneſs of mind is there in a generoſity which follows on the uſurpation of the ſupreme power?

" Nature, while it marked Cæſar with a ſublime character, gave him alſo that ſpirit of perſeverance which renders it uſeful. He had no ſooner begun to reflect, than he admired Sylla; hated him, and yet wiſhed to imitate him. At the age of 15, he formed the project of being dictator. It was thus that the preſident Monteſquieu conceived, in his early youth, the idea of the Spirit of Laws.

" Phyſical qualities, as well as moral cauſes, contributed to give ſtrength to his character. Nature, which had made him for command, had given him an air of dignity. He had acquired that ſoft and inſinuating eloquence, which is perfectly ſuited to ſeduce vulgar minds, and has a powerful influence on the moſt cultivated. His love of pleaſure was a merit with the fair ſex; and women, who even in a republic can draw to them the ſuffrages and attention of men, have the higheſt importance in degenerate times. The ladies of his age were charmed with the proſpect of having a dictator whom they might ſubdue by their attractions.

" In vain did the genius of Cato watch for ſome time to ſuſtain the liberty of his country. It was unequal to contend with that of Cæſar. Of what avail were the eloquence, the philoſophy, and the virtue of this republican, when oppoſed by a man who had the addreſs to debauch the wife of every citizen whoſe intereſt he meant to engage; who, poſſeſſing an enthuſiaſm for glory, wept, becauſe, at the age of 30, he had not conquered the world like Alexander; and who, with the haughty temper of a deſpot, was more deſirous to be the firſt man in a village than the ſecond in Rome.

" Cæſar had the good fortune to exiſt in times of trouble and civil commotions, when the minds of men are put into a ferment; when opportunities of great actions are frequent; when talents are every thing, and thoſe who can only boaſt of their virtues are nothing. If he had lived an hundred years ſooner, he would have been no more than an obſcure villain; and, inſtead of giving laws to the world, would not have been able to produce any confuſion in it.

" I will here be bold enough to advance an idea, which may appear paradoxical to thoſe who weakly judge of men from what they achieve, and not from the principle which leads them to act. Nature formed in the ſame mould Cæſar, Mahomet, Cromwell, and Kouli Khan. They all of them united to genius that profound policy which renders it ſo powerful. They all of them had an evident ſuperiority over thoſe with whom they were ſurrounded; they were conſcious of this ſuperiority, and they made others conſcious of it. They were all of them born ſubjects, and became fortunate uſurpers. Had Cæſar been placed in Perſia, he would have made the conqueſt of India; in Arabia, he would have been the founder of a new religion; in London, he would have ſtabbed his ſovereign, or have procured his aſſaſſination under the ſanction of the laws. He reigned with glory over men whom he had reduced to be ſlaves; and, under one aſpect, he is to be conſidered as a hero; under another as a monſter. But it would be unfortunate, indeed, for ſociety, if the poſſeſſion of ſuperior talents gave individuals a right to trouble its repoſe. Uſurpers accordingly have flatterers, but no friends; ſtrangers reſpect them; their ſubjects complain and ſubmit; it is in their own families that humanity finds her avengers. Cæſar was aſſaſſinated by his ſon, Mahomet was poiſoned by his wife, Kouli Khan was maſſacred by his nephew, and Cromwell only died in his bed becauſe his ſon Richard was a philoſopher.

" Cæſar, the tyrant of his country; Cæſar, who deſtroyed the agents of his crimes, if they failed in addreſs; Cæſar, in fine, the huſband of every wife, and the wife of every huſband, has been accounted a great man by the mob of writers. But it is only the philoſopher who knows how to mark the barrier between celebrity and greatneſs. The talents of this ſingular man, and the good fortune which conſtantly attended him till the moment of his aſſaſſination, have concealed the enormity of his actions."

Cæsar, in Roman antiquity, a title borne by all the emperors, from Julius Cæſar to the deſtruction of the empire. It was alſo uſed as a title of diſtinction for the intended or preſumptive heir of the empire, as *king of the Romans* is now uſed for that of the German empire.

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* From the *Melanges Philoſophiques* of M. Ophellot.

This title took its riſe from the ſurname of the firſt emperor, C. Julius Cæſar, which, by a decree of the ſenate, all the ſucceeding emperors were to bear. Under his ſucceſſor, the appellation of *Auguſtus* being appropriated to the emperors, in compliment to that prince, the title *Cæſar* was given to the ſecond perſon in the empire, though ſtill it continued to be given to the firſt; and hence the difference betwixt Cæſar uſed ſimply, and Cæſar with the addition of Imperator Auguſtus.

The dignity of Cæſar remained to the ſecond of the empire, till Alexius Comnenus having elected Nicephorus Meliſſenus Cæſar by contract; and it being neceſſary to confer ſome higher dignity on his own brother Iſaacius, he created him Sebaſtocrator with the precedency over Meliſſenus; ordering, that in all acclamations, &c. Iſaacius Sebaſtocrator ſhould be named the ſecond, and Meliſſenus Cæſar the third.

CÆSAR, *Sir Julius*, a learned civilian, was deſcended by the female line from the duke de Ceſarini in Italy; and was born near Tottenham in Middleſex, in the year 1557. He was educated at Oxford, and afterwards ſtudied in the univerſity of Paris, where, in the year 1581, he was created doctor of the civil law, and two years after was admitted to the ſame degree at Oxford, and alſo became doctor of the canon law. He was advanced to many honourable employments, and for the laſt 20 years of his life was maſter of the rolls. He was remarkable for his extenſive bounty and charity to all perſons of worth, ſo that he ſeemed to be the almoner-general of the nation. He died in 1639, in the 79th year of his age. It is very remarkable that the manuſcripts of this lawyer were offered (by the executors of ſome of his deſcendants) to a cheeſemonger for waſte paper; but being timely inſpected by Mr Samuel Paterſon, this gentleman diſcovered their worth, and had the ſatisfaction to find his judgment confirmed by the profeſſion, to whom they were ſold in lots for upwards of 500l. in the year 1757.

CÆSAR *Auguſta*, or *Cæſarea Auguſta*, in *Ancient Geography*, a Roman colony ſituated on the river Iberus in the Hither Spain, before called *Salduba*, in the territories of the Edetani. Now commonly thought to be Saragoſſa.

CÆSAREA, the name of ſeveral ancient cities, particularly one on the coaſt of Phœnicia. It was very conveniently ſituated for trade; but had a very dangerous harbour, ſo that no ſhips could be ſafe in it when the wind was at ſouth-weſt. Herod the Great king of Judea remedied this inconveniency at an immenſe expenſe and labour, making it one of the moſt convenient havens on that coaſt. He alſo beautified it with many buildings, and beſtowed 12 years on the finiſhing and adorning it.

CÆSARERAN operation. See MIDWIFERY.

CÆSARIANS, *Cæſarienſes*, in Roman antiquity, were officers or miniſters of the Roman emperors: They kept the account of the revenues of the emperors; and took poſſeſſion, in their name, of ſuch things as devolved or were confiſcated to them.

CÆSARODUNUM, in *Ancient Geography*, a town of the Turones in Celtic Gaul; now *Tours*, the capital of Touraine. See TOURS.

CÆSAROMAGUS, in *Ancient Geography*, a town of the Trinobantes in Britain; by ſome ſuppoſed to be *Chelmsford*, by others *Brentford*, and by others *Purfleet*.

CÆSENA, in *Ancient Geography*, a town of Gallia Ciſpadana, ſituated on the rivers Iſapis and Rubicon; now CECENA, which ſee.

CÆSIA SYLVA, in *Ancient Geography*, a wood in Germany, part of the great Sylva Hercynia, ſituated partly in the duchy of Cleves, and partly in Weſtphalia, between Weſel and Keſfield.

CÆSONES, a denomination given to thoſe cut out of their mothers wombs. Pliny ranks this as an auſpicious kind of birth; the elder Scipio Africanus, and the firſt family of Cæſars, were brought into the world in this way.

CÆSTUS, in antiquity, a large gauntlet made of raw hide, which the wreſtlers made uſe of when they fought at the public games.—This was a kind of leathern ſtrap, ſtrengthened with lead or plates of iron, which encompaſſed the hand, the wriſt, and a part of the arm, as well to defend theſe parts as to enforce their blows.

CÆSTUS, or *Cæſtum*, was alſo a kind of girdle, made of wool, which the huſband untied for his ſpouſe the firſt day of marriage, before they went to bed.

This relates to Venus's girdle, which Juno borrowed of her to entice Jupiter to love her. See CESTUS.

CÆSURA, in the ancient poetry, is when, in the ſcanning of a verſe, a word is divided ſo, as one part ſeems cut off, and goes to a different foot from the reſt; as,

Menti|ri no|li, nun|quam men|dacia|proſunt.

where the ſyllables *ri*, *li*, *quam*, and *men*, are cæſuras.

CÆSURA, in the modern poetry, denotes a reſt or pauſe towards the middle of an Alexandrian verſe, by which the voice and pronunciation are aided, and the verſe, as it were, divided into two hemiſtichs. See PAUSE.

CÆTERIS PARIBUS, a Latin term in frequent uſe among mathematical and phyſical writers. The words literally ſignify, *the reſt (or other things) being alike or equal.* Thus we ſay the heavier the bullet, *cæteris paribus*, the greater the range; i. e. by how much the bullet is heavier, if the length and diameter of the piece and ſtrength of the powder be the ſame, by ſo much will the utmoſt range or diſtance of a piece of ordnance be the greater. Thus alſo, in a phyſical way, we ſay, the velocity and quantity circulating in a given time through any ſection of an artery, will, *cæteris paribus*, be according to its diameter, and nearneſs to or diſtance from the heart.

CÆTOBRIX, in *Ancient Geography*, a town of Luſitania, near the mouth of the Tagus on the eaſt ſide; now extinct. It had its name from its fiſhery; and there are ſtill extant fiſh ponds on the ſhore, done with plaſter of Paris, which illuſtrate the name of the ruined city.

CAFFA, in commerce, painted cotton cloths manufactured in the Eaſt Indies, and ſold at Bengal.

CAFFA, or *Kaffa*, a city and port town of Crim Tartary, ſituated on the ſouth-eaſt part of that peninſula. E. Long. 37. 0. N. Lat. 44. 55.

It is the moſt conſiderable town in the country, and gives name to the ſtraits of Caffa, which runs from the Euxne or Black ſea, to the Palus Mæotis, or ſea of Aſoph.

CAFFILA, a company of merchants or travellers, who join together in order to go with more ſecurity through the dominions of the Great Mogul, and through other countries on the continent of the Eaſt Indies.

The caffila differs from a caravan, at leaſt in Perſia; for the caffila belongs properly to ſome ſovereign, or to ſome powerful company in Europe; whereas a caravan is a company of particular merchants, each trading upon his own account. The Engliſh and Dutch have each of them their caffila at Gambrow. There are alſo ſuch caffilas, which croſs ſome parts of the deſerts of Africa, particularly that called the *ſea of ſand*, which lies between the kingdom of Morocco and thoſe of Tombut and Gaigo. This is a journey of 400 leagues; and takes up two months in going, and as many in coming back; the caffila travelling only by night, on account of the exceſſive heat of that country. The chief merchandiſe they bring back conſiſts in gold duſt, which they call *atibar*, and the Europeans *tibir*.

CAFFILA, on the coaſt of Guzerat or Cambaya, ſignifies a ſmall fleet of merchant ſhips.

CAFFRARIA, the country of the Caffres or Hottentots, in the moſt ſoutherly parts of Africa, lying in the form of a creſcent about the inland country of Monomotapa between 35° ſouth latitude and the tropic of Capricon: and bounded on the eaſt, ſouth, and weſt, by the Indian and Atlantic oceans. See HOTTENTOTS.

Moſt of the ſea coaſts of this country are ſubject to the Dutch, who have built a fort near the moſt ſouthern promontory called the *Cape of Good Hope*.

CAG, or KEG, a barrel or veſſel that contains ſome four or five gallons.

CAGANUS, or CACANUS, an appellation anciently given by the Huns to their kings. The word appears alſo to have been formerly applied to the princes of Muſcovy, now called *czar*. From the ſame alſo, probably, the Tartar title *cham* or *can*, had its origin.

CAGE, an encloſure made of wire, wicker, or the like, interwoven lattice-wiſe, for the confinement of birds or wild beaſts. The word is French, *cage*, formed from the Italian *gaggia*, of the Latin *cavea* which ſignifies the ſame: *a caveis theatralibus in quibus includebantur feræ*.

Beaſts were uſually brought to Rome ſhut up in oaken or beechen cages artfully formed, and covered or ſhaded with boughs, that the creatures deceived with the appearance of a wood, might fancy themſelves in their foreſt. The fiercer ſorts were pent in iron cages, leſt wooden priſons might be broke through. In ſome priſons there are iron cages for the cloſer confinement of criminals. The French laws diſtinguiſh two ſorts of birds cages; viz. high or ſinging cages, and low or dumb cages; thoſe who expoſe birds to ſale are obliged to put the hens in the latter, and the cocks in the former, that perſons may not be impoſed on by buying a hen for a cock.

CAGES (*caveæ*), denote alſo places in the ancient amphitheatres, wherein wild beaſts were kept, ready to be let out for ſport. The *caveæ* were a ſort of iron cages different from dens, which were under ground and dark; whereas the *caveæ* being airy and light, the beaſts ruſhed out of them with more alacrity and fierceneſs than if they had been pent under ground.

CAGE, in carpentry, ſignifies an outer work of timber, incloſing another within it. In this ſenſe we ſay, *the cage of a wind-mill*. The cage of a ſtaircaſe denotes the wooden ſides or walls which encloſe it.

CAGEAN, or CAGAYAN, a province of the iſland of Luzon, or Manilla, in the Eaſt Indies. It is the largeſt in the iſland, being 80 leagues in length and 40 in breadth. The principal city is called *New Segovia*, and 15 leagues eaſtward from this city lies Cape Bajador. Doubling that cape, and coaſting along 20 leagues from north to ſouth, the province of Cagean ends, and that of Illocos begins. The peaceable Cageans who pay tribute are about 9000; but there are a great many not ſubdued. The whole province is fruitful; the men apply themſelves to agriculture, and are of a martial diſpoſition; and the women apply to ſeveral works in cotton. The mountains afford food for a vaſt number of bees; in conſequence of which wax is ſo plenty, that all the poor burn it inſtead of oil. They make their candles after the following manner: they leave a ſmall hole at each end of a hollow ſtick for the wick to run through, and then, ſtopping the bottom, fill it with wax at the top; when cold, they break the mould and take out the candle. On the mountains there is abundance of braſil, ebony, and other valuable woods. In the woods are ſtore of wild beaſts, as boars; but not ſo good as thoſe of Europe. There are alſo abundance of deer which they kill for their ſkins and horns to ſell to the Cheneſe.

CAGLI, an ancient epiſcopal town of Italy, in the duchy of Urbino, ſituated at the foot of the Apennine mountains. E Long. 14. 12. N. Lat. 43. 30.

CAGLIARI, PAOLO, called *Paulo Veroneſe*, an excellent painter, was born at Verona in the year 1532. Gabriel Cagliari his father was a ſculptor, and Antonio Badile his uncle was his maſter in painting. He was not only eſteemed the beſt of all the Lombard painters, but for his extenſive talents in the art was peculiarly ſtyled *Il pittor felice*, "the happy painter;" and there is ſcarcely a church in Venice where ſome of his performances are not to be ſeen. De Pile ſays, that "his picture of the marriage at Cana, in the church of St George, is to be diſtinguiſhed from his other works, as being not only the triumph of Paul Veroneſe, but almoſt the triumph of painting itſelf." When the ſenate ſent Grimani, procurator of St Mark, to be their ambaſſador at Rome, Paul attended him, but did not ſtay long, having left ſome pieces at Venice unfiniſhed. Philip II king of Spain, ſent for him to paint the Eſcurial, and made him great offers; but Paul excuſed himſelf from leaving his own country, where his reputation was ſo well eſtabliſhed, that moſt of the princes of Europe ordered their ſeveral ambaſſadors to procure ſomething of his hand at any rate. He was indeed highly eſteemed by all the principal men in his time; and ſo much admired by the great maſters, as well his contemporaries, as thoſe who ſucceeded him, that Titian himſelf uſed to ſay, he was the ornament of his profeſſion. And Guido Reni being aſked which of the maſters his predeceſſors he would chooſe to be, were it in his power, after Raphael and Corregio, named Paul Veroneſe; whom he always called his Paolino. He died of a fever at Venice in 1588, and had a tomb and a ſtatue of braſs erected to his memory in the church of St Sebaſtian. He left great wealth to his two ſons Gabriel and Charles, who lived happily together, and joined in finiſhing ſeveral of their father's imperfect pieces with good ſucceſs.

CAGLIARI, an ancient, large, and rich town, capital of the iſland of Sardinia in the Mediterranean. It is ſeated on the declivity of a hill; is an univerſity, an archbiſhopric, and the reſidence of the viceroy. It has an excellent harbour, and a good trade; but is a place of no great ſtrength. It was taken, with the whole iſland, by the Engliſh in 1708, who transferred it to the emperor Charles VI.; but it was retaken by the Spaniards in 1717, and about two years afterwards ceded to the duke of Savoy in lieu of Sicily, and hence he has the title of *king of Sardinia*. E. Long. 9. 14. N. Lat. 39. 12.

CAGUI, in *Zoology*, a ſynonyme of two ſpecies of monkeys, viz. the jacchus and œdipus. See SIMIA, MAMMALIA *Index*.

CAHORS, a conſiderable town of France, in Quercy in Guienne, with a biſhop's ſee and a univerſity. It is ſeated on a peninſula made by the river Lot, and built partly on a craggy rock. The principal ſtreet is very narrow; and terminates in the market place, in which is the town-houſe. The cathedral is a Gothic ſtructure, and has a large ſquare ſteeple. The fortifications are regular, and the town is ſurrounded with thick walls. E. Long. 1. 6. N. Lat. 44. 26.

CAHYS, a dry meaſure for corn, uſed in ſome parts of Spain, particularly at Seville and at Cadiz. It is near a buſhel of our meaſure.

CAJANABURG, the capital of the province of Cajania or Eaſt Bothnia in Sweden, ſituated on the north eaſt part of the lake Cajania, in E. Long. 27. 0. N. Lat. 63. 50.

CAIAPHAS, high prieſt of the Jews after Simon, condemned Chriſt to death: and was put out of his place by the emperor Vitellius, for which diſgrace he made away with himſelf.

CAJAZZO, a town of the province of Lavoro in the kingdom of Naples, ſituated in E. Long. 15. 0. N. Lat. 41. 15.

CAICOS, the name of ſome American iſlands to the north of St Domingo, lying from W. Long. 112. 10. to 113. 16. N. Lat. 21. 40.

CAJEPUT, an oil brought from the Eaſt Indies, reſembling that of cardamoms. See MELALEUCA.

CAIETA, in *Ancient Geography*, a port and town of Latium, ſo called from Eneas's nurſe; now *Gaeta*, which ſee.

CAJETAN, CARDINAL, was born at Cajeta in the kingdom of Naples in the year 1469. His proper name was *Thomas de Vio*; but he adopted that of *Cajetan* from the place of his nativity. He defended the authority of the pope, which ſuffered greatly at the council of Nice, in a work entitled *Of the power of the Pope*; and for this work he obtained the biſhopric of Cajeta. He was afterwards raiſed to the archiepiſcopal ſee of Palermo, and in 1517 was made a cardinal by Pope Leo X. The year after, he was ſent as legate into Germany, to quiet the commotions raiſed againſt indulgencies by Martin Luther; but Luther, under protection of Frederic elector of Saxony, ſet him at defiance; for though he obeyed the cardinal's ſummons, in repairing to Augſburg, yet he rendered all his proceedings ineffectual. Cajetan was employed in ſeveral other negotiations and tranſactions, being as ready at buſineſs as at letters. He died in 1534. He wrote Commentaries upon Ariſtotle's philoſophy, and upon Thomas Aquinas's theology; and made a literal tranſlation of the Old and New Teſtaments.

CAIFONG, a large, populous, and rich town of Aſia, in China, ſeated in the middle of a large and well cultivated plain. It ſtands in a bottom; and when beſieged by the rebels in 1642, they ordered the dykes of the river Hoang-ho to be cut, which drowned the city, and deſtroyed 300,000 of its inhabitants. E. Long. 113. 27. N. Lat. 35. 0.

CAILLE, NICHOLAS LOUIS DE LA, an eminent mathematician and aſtronomer, was born at a ſmall town in the dioceſe of Rheims in 1713. His father had ſerved in the army, which he quitted, and in his retirement ſtudied mathematics; and amuſed himſelf with mechanic exerciſes, wherein he proved the happy author of ſeveral inventions of conſiderable uſe to the public. Nicholas, almoſt in his infancy, took a fancy to mechanics, which proved of ſignal ſervice to him in his maturer years. He was ſent young to ſchool at Mantes-ſur-Seine, where he diſcovered early tokens of genius. In 1729, he went to Paris; where he ſtudied the claſſics, philoſophy, and mathematics. Afterwards he went to ſtudy divinity at the college de Navarre, propoſing to embrace an eccleſiaſtical life. At the end of three years he was ordained a deacon, and officiated as ſuch in the church of the college de Mazarin ſeveral years; but he never entered into prieſts orders, apprehending that his aſtronomical ſtudies, to which he became moſt aſſiduouſly devoted, might too much interfere with his religious duties. In 1739, he was conjoined with M. de Thury, ſon to M. Caſſini, in verifying the meridian of the royal obſervatory through the whole extent of the kingdom of France. In the month of November the ſame year, whilſt he was engaged day and night in the operations which this grand undertaking required, and at a great diſtance from Paris, he was, without any ſolicitation, elected into the vacant mathematical chair which the celebrated M. Varignon had ſo worthily filled. Here he began to teach about the end of 1740; and an obſervatory was ordered to be erected for his uſe in the college, and furniſhed with a ſuitable apparatus of the beſt inſtruments. In May 1741, M. de la Caille was admitted into the Royal Academy of Sciences as an adjoint member for aſtronomy. Beſides the many excellent papers of his diſperſed up and down in their memoirs, he publiſhed Elements of Geometry, mechanics, optics, and aſtronomy. Moreover, he carefully computed all the eclipſes of the ſun and moon that had happened ſince the Chriſtian era, which were printed in a book publiſhed by two Benedictines, entitled *l' art de verifier les dates*, &c. Paris, 1750, in 4to. Beſides theſe he compiled a volume of aſtronomical ephemerides for the years 1745 to 1755; another for the years 1755 to 1765; a third for the years 1765 to 1775: an excellent work entitled *Aſtronomiæ funda-*

menta noviſſimis ſolis et ſtellarum obſervationibus ſtabilita: and the moſt correct ſolar tables that ever appeared. Having gone through a ſeven years ſeries of aſtronomical obſervations in his own obſervatory, he formed a project of going to obſerve the ſouthern ſtars at the Cape of Good Hope. This was highly approved by the academy, and by the prime miniſter Comte de Argenſon, and very readily agreed to by the ſtates of Holland. Upon this he drew up a plan of the method he propoſed to purſue in his ſouthern obſervations; ſetting forth, that, beſides ſettling the places of the fixed ſtars, he propoſed to determine the parallax of the moon, Mars and Venus. But whereas this required correſpondent obſervations to be made in the northern parts of the world, he ſent to thoſe of his correſpondents who were expert in practical aſtronomy previous notice, in print, what obſervations he deſigned to make at ſuch and ſuch times for the ſaid purpoſe. At length, on the 21ſt of November 1750, he ſailed for the Cape, and arrived there on the 19th of April 1751. He forthwith got his inſtruments on ſhore; and with the aſſiſtance of ſome Dutch artificers, ſet about building an aſtronomical obſervatory, in which his apparatus of inſtruments was properly diſpoſed of as ſoon as it was in a fit condition to receive them.

The ſky at the Cape is generally pure and ſerene, unleſs when a ſouth-eaſt wind blows: But this is often the caſe, and when it is, it is attended with ſome ſtrange and terrible effects. The ſtars look bigger, and ſeem to caper; the moon has an undulating tremor; and the planets have a ſort of beard like comets. Two hundred and twenty-eight nights did our aſtronomer ſurvey the face of the ſouthern heavens: during which ſpace, which is almoſt incredible, he obſerved more than 10,000 ſtars; and whereas the ancients filled the heavens with monſters and old wives tales, the abbé de la Caille choſe rather to adorn them with the inſtruments and machines which modern philoſophy has made uſe of for the conqueſt of nature.* With no leſs ſucceſs did he attend to the parallax of the moon, Mars, Venus, and the ſun. Having thus executed the purpoſe of his voyage, and no preſent opportunity offering for his return, he thought of employing the vacant time in another arduous attempt; no leſs than that of taking the meaſure of the earth, as he had already done that of the heavens. This, indeed, had, through the munificence of the French king, been done before by different ſets of learned men both in Europe and America; ſome determining the quantity of a degree under the equator, and others under the arctic circle: but it had not as yet been decided whether in the ſouthern parallels of latitude the ſame dimenſions obtained as in the northern. His labours were rewarded with the ſatisfaction he wiſhed for; having determined a diſtance of 410,814 feet from a place called *Klip Fontyn* to the Cape, by means of a baſe of 38,802 feet, three times actually meaſured: whence he diſcovered a new ſecret of nature, namely, that the radii of the parallels in ſouth latitude are not the ſame as thoſe of the correſponding parallels in north latitude. About the 23d degree of ſouth latitude he found a degree on the meridian to contain 342,222 Paris feet. He returned to Paris the 27th of September 1754; having in his almoſt four years abſence expended no more than 9144 livres on himſelf and his companion; and at his coming into port, he refuſed a bribe of 100,000 livres, offered by one who thirſted leſs after glory than gain, to be ſharer in his immunity from cuſtomhouſe ſearches.

After receiving the congratulatory viſits of his more intimate friends and the aſtronomers, he firſt of all thought fit to draw up a reply to ſome ſtrictures which Profeſſor Euler had publiſhed relative to the meridian, and then he ſettled the reſults of the compariſon of his own with the obſervations of other aſtronomers for the parallaxes. That of the ſun he fixed at 9½″; of the moon at 56′ 56″; of Mars in his oppoſition, 36″; of Venus, 38″. He alſo ſettled the laws whereby aſtronomical refractions are varied by the different denſity or rarity of the air, by heat or cold, and dryneſs or moiſture. And, laſtly, He ſhowed an eaſy, and by common navigators practicable, method of finding the longitude at ſea by means of the moon, which he illuſtrated by examples ſelected from his own obſervations during his voyages. His fame being now eſtabliſhed upon ſo firm a baſis, the moſt celebrated academies of Europe claimed him as their own: and he was unanimouſly elected a member of the royal ſociety at London; of the inſtitute of Bologna; of the imperial academy at Peterſburgh; and of the royal academies at Berlin, Stockholm, and Gottingen. In the year 1760, M. de la Caille was attacked with a ſevere fit of the gout; which, however, did not interrupt the courſe of his ſtudies; for he then planned out a new and immenſe work; no leſs than the hiſtory of aſtronomy through all ages, with a compariſon of the ancient and modern obſervations, and the conſtruction and uſe of the inſtruments employed in making them. In order to purſue the taſk he had impoſed upon himſelf in a ſuitable retirement, he obtained a grant of apartments in the royal palace of Vincennes; and whilſt his aſtronomical apparatus was erecting there, he began printing his Catalogue of the Southern Stars, and the third volume of his Ephemerides. The ſtate of his health was, towards the end of the year 1763, greatly reduced. His blood grew inflamed; he had pains of the head, obſtructions of the kidneys, loſs of appetite, with a fulneſs of the whole habit. His mind remained unaffected, and he reſolutely perſiſted in his ſtudies as uſual. In the month of March, medicines were adminiſtered to him, which rather aggravated than alleviated his ſymptoms; and he was now ſenſible, that the ſame diſtemper which in Africa, ten years before, yielded to a few ſimple remedies, did in his native country bid defiance to the beſt phyſicians. This induced him to ſettle his affairs: his manuſcripts he committed to the care and diſcretion of his eſteemed friend M. Maraldi. It was at laſt determined that a vein ſhould be opened; but this brought on an obſtinate lethargy, of which he died, aged 49.

CAIMACAN, or **KAIMACAM**, in the Turkiſh affairs, a dignity in the Ottoman empire, anſwering to lieutenant, or rather deputy, amongſt us.

There are uſually two caimacans; one reſiding at Conſtantinople, as governor thereof; the other attending the grand vizir in quality of his lieutenant, ſecretary of ſtate, and firſt miniſter of his council, and gives audience to ambaſſadors. Sometimes there is a third caimacan, who attends the ſultan; whom he acquaints with any public diſturbances, and receives his orders concerning them.

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* See the Planiſphere in his *Cælum auſtrale ſtelliferum.*

CAIMAN, or CAYMAN ISLANDS, certain American iſlands lying ſouth of Cuba, and north-weſt of Jamaica, between 81° and 86° of weſt longitude, and in 21° of north latitude. They are moſt remarkable on account of the fiſhery of tortoiſe, which the people of Jamaica catch here and carry home alive, keeping them in pens for food, and killing them as they want them.

CAIN, eldeſt ſon of Adam and Eve, killed his brother Abel; for which he was condemned by God to baniſhment and a vagabond ſtate of life. Cain retired to the land of Nod, on the eaſt of Eden; and built a city, to which he gave the name of his ſon Enoch.

CAINITES, a ſect of heretics in the 2d century, ſo called on account of their great reſpect for Cain. They pretended that the virtue which produced Abel was of an order inferior to that which had produced Cain, and that this was the reaſon why Cain had the victory over Abel and killed him; for they admitted a great number of genii, which they called *virtues*, of different ranks and orders. They made profeſſion of honouring thoſe who carry in Scripture the moſt viſible marks of reprobation; as the inhabitants of Sodom, Eſau, Korah, Dathan, and Abiram. They had, in particular, a very great veneration for the traitor Judas, under pretence that the death of Jeſus Chriſt had ſaved mankind. They had a forged goſpel of Judas, to which they paid great reſpect.

CAIRNS, or CARNES, the vulgar name of thoſe heaps of ſtones which are to be ſeen in many places of Britain, particularly Scotland and Wales.—They are compoſed of ſtones of all dimenſions thrown together in a conical form, a flat ſtone crowning the apex; (ſee Plate CXXXV.

Various cauſes have been aſſigned by the learned for theſe heaps of ſtones. They have ſuppoſed them to have been, in times of inauguration, the places where the chieftan elect ſtood to ſhow himſelf to beſt advantage to the people; or the place from whence judgement was pronounced; or to have been erected on the road-ſide in honour of Mercury; or to have been formed in memory of ſome ſolemn compact, particularly where accompanied by ſtanding pillars of ſtones; or for the celebration of certain religious ceremonies. Such might have been the reaſons, in ſome inſtances, where the evidences of ſtone cheſts and urns are wanting: but theſe are ſo generally found that they ſeem to determine the moſt uſual purpoſe of the piles in queſtion to have been for ſepulchral monuments. Even this deſtination might render them ſuitable to other purpoſes; particularly religious, to which by their nature they might be ſuppoſed to give additional ſolemnity.—According to Toland, fires were kindled on the tops of flat ſtones, at certain times of the year, particularly on the eves of the 1ſt of May and the 1ſt of November, for the purpoſe of ſacrificing; at which time all the people having extinguiſhed their domeſtic hearths rekindled them from the ſacred fires of the cairns. In general, therefore, theſe accumulations appear to have been deſigned for the ſepulchral protection of heroes and great men. The ſtone cheſts, the repoſitory of the urns and aſhes, are lodged in the earth beneath: ſometimes only one, ſometimes more, are found thus depoſited; and Mr Pennant mentions an inſtance of 17 being diſcovered under the ſame pile.

Cairns are of different ſizes, ſome of them very large. Mr Pennant deſcribes one in the iſland of Arran, 114 feet over, and of a vaſt height. They may juſtly be ſuppoſed to have been proportioned in ſize to the rank of the perſon, or to his popularity: the people of a whole diſtrict aſſembled to ſhow their reſpect to the deceaſed; and, by an active honouring of his memory, ſoon accumulated heaps equal to thoſe that aſtoniſh us at this time. But theſe honours were not merely thoſe of the day; as long as the memory of the deceaſed endured, not a paſſenger went by without adding a ſtone to the heap: they ſuppoſed it would be an honour to the dead, and acceptable to his manes.

Quanquam feſtinas, non eſt mora longa: licebit
Injecto ter pulvera, curras.

To this moment there is a proverbial expreſſion among the Highlanders alluſive to the old practice; a ſuppliant will tell his patron, *Curri mi cloch er do charne*, "I will add a ſtone to your cairn;" meaning, When you are no more, I will do all poſſible honour to your memory.

Cairns are to be found in all parts of our iſlands, in Cornwall, Wales, and all parts of North Britain; they were in uſe among the northern nations; Dahlberg, in his 323d plate, has given the figure of one. In Wales they are called *carnedlau*; but the proverb taken from them there, is not of the complimental kind: *Karn ar dy ben*, or, "A cairn on your head," is a token of imprecation.

CAIRO, or GRAND CAIRO, the capital of Egypt, ſituated in a plain at the foot of a mountain, in E. Long. 32. 0. N. Lat. 30. 0. It was founded by Jawhar, a Magrebian general, in the year of the Hegira 358. He had laid the foundation of it under the horoſcope of Mars; and for that reaſon gave his new city the name of *Al Kahira*, or the *Victorious*, an epithet applied by the Arab aſtronomers to that planet. In 362 it became the reſidence of the caliphs of Egypt; and of conſequence the capital of that country, and has ever ſince continued to be ſo. It is divided into the New and Old cities. Old Cairo is on the eaſtern ſide of the river Nile, and is now almoſt uninhabited. The new, which is properly Cairo, is ſeated in a ſandy plain about two miles and a half from the old city. It ſtands on the weſtern ſide of the Nile, from which it is not three quarters of a mile diſtant. It is extended along the mountain on which the caſtle is built, for the ſake of which it was removed hither, in order, as ſome pretend, to be under its protection. However, the change is much for the worſe, as well with regard to air as water, and the pleaſantneſs of the proſpect. Bulack may be called the port of Cairo; for it ſtands on the bank of the Nile, about a mile and a half from it, and all the corn and other commodities are landed there before they are brought to the city. Some travellers have made Cairo of a moſt enormous magnitude, by taking in the old city, Bulack, and the new; the real circumference of it, however, is not above ten miles, but it is extremely populous. The firſt thing that ſtrikes a traveller is the narrowneſs of the ſtreets, and the appearance of the houſes. Theſe are ſo daubed with mud on the outſide, that you would think they were built with nothing elſe. Beſides, as the ſtreets are unpaved, and always full of people, the walking in them is very inconvenient, eſpecially to ſtrangers. To remedy this, there are a great number of aſſes, which always ſtand ready to be hired for a trifle, that is, a penny a mile. The owners drive them along, and give notice to the crowd to make way. And here it may be obſerved, that the Chriſtians in this, as well as other parts of the Turkiſh dominions, are not permitted to ride upon horſes. The number of the inhabitants can only be gueſſed at; but we may conclude it to be very great, becauſe in ſome years the plague will carry off 200,000, without their being much miſſed. The houſes are from one to two or three ſtories high, and flat at the top; where they take the air, and often ſleep all night. The better ſort of theſe have a court on the inſide like a college. The common run of houſes have very little room, and even among great people it is uſual for 20 or 30 to lie in a ſmall hall. Some houſes will hold 300 perſons of both ſexes, among whom are 20 or 30 ſlaves; and thoſe of ordinary rank have generally three or four.

There is a canal called *khalis*, which runs along the city from one end to the other, with houſes on each ſide, which make a large ſtraight ſtreet. Beſides this, there are ſeveral lakes, which are called *birks* in the language of the country. The principle of theſe, which is near the caſtle, is 500 paces in diameter. The moſt elegant houſes in the city are built on its banks; but what is extraordinary, eight months in the year it contains water, and the other four it appears with a charming verdure. When there is water ſufficient, it is always full of gilded boats, barges, and barks, in which people of condition take their pleaſure towards night, at which time there are curious fireworks, and variety of muſic.

New Cairo is ſurrounded with walls built with ſtone, on which are handſome battlements, and at the diſtance of every hundred paces there are very fine towers, which have room for a great number of people. The walls were never very high, and are in many places gone to ruin. The baſha lives in the caſtle, which was built by Saladine 700 years ago. It ſtands in the middle of the famous mountain Moketan, which terminates in this place, after it had accompanied the Nile from Ethiopia hither. This caſtle is the only place of defence in Egypt; and yet the Turks take no notice of its falling, inſomuch that in proceſs of time it will become a heap of rubbiſh. The principal part in it is a magnificent hall, environed with 12 columns of granite, of a prodigious height and thickneſs, which ſuſtain an open dome, under which Saladine diſtributed juſtice to his ſubjects. Round this dome there is an inſcription in relievo, which determines the date and by whom it was built. From this place the whole city of Cairo may be ſeen, and above 30 miles along the Nile, with the fruitful plains that lie near it, as well as the moſques, pyramids, villages, and gardens, with which theſe fields are covered. Theſe granite pillars were the work of antiquity, for they were got out of the ruins of Alexandria. There are likewiſe in the moſques and in the principal houſes no leſs than 40,000 more, beſides great magazines, where all kinds are to be had at very low rates. A janizary happened to find five in his garden, as large as thoſe in the caſtle; but could not find any machine of ſtrength ſufficient to move them, and therefore had them ſawed in pieces to make millſtones. It is believed that there have been 30 or 40,000 of theſe pillars brought from Alexandria, where there are yet many more to be had. The gates of Cairo are three, which are very fine and magnificent.

There are about 300 public moſques in this city, ſome of which have ſix minarets. The moſque of Aſher hath ſeveral buildings adjoining, which were once a famous univerſity, and 14,000 ſcholars and ſtudents were maintained on the foundation; but it has now not above 1400, and thoſe are only taught to read and write. All the moſques are built upon the ſame plan, and differ only in magnitude. The entrance is through the principal gate into a large ſquare, open on the top, but well paved. Round this are covered galleries, ſupported by pillars; under which they ſay their prayers, in the ſhade. On one ſide of the ſquare there are particular places with baſons of water for the conveniency of performing the ablutions enjoined by the Koran. The moſt remarkable part of the moſque, beſides the minaret, is the dome. This is often bold, well proportioned, and of an aſtoniſhing magnitude. The inſide ſtones are carved like lace, flowers, and melons. They are built ſo firm, and with ſuch art, that they will laſt 600 or 700 years. About the outward circumference there are large Arabic inſcriptions in relievo, which may be read by thoſe who ſtand below, though they are ſometimes of a wonderful height.

The khanes or caravanſeras are numerous and large, with a court in the middle, like their houſes. Some are ſeveral ſtories high, and are always full of people and merchandiſe. The Nubians, the Abyſſinians, and other African nations, which come to Cairo, have one to themſelves, where they always meet with lodging. Here they are ſecure from inſults, and their effects are all ſafe. Beſides theſe there is a bazar, or market, where all ſorts of goods are to be ſold. This is in a long broad ſtreet; and yet the crowd is ſo great, you can hardly paſs along. At the end of this ſtreet is another ſhort one, but pretty broad, with ſhops full of the beſt ſort of goods and precious merchandiſe. At the end of this ſhort ſtreet there is a great khane, where all ſorts of white ſlaves are to be ſold. Farther than this is another khane, where a great number of blacks, of both ſexes, are expoſed to ſale. Not far from the beſt market place is a moſque, and an hoſpital for mad people. They alſo receive and maintain ſick people in this hoſpital, but they are poorly looked after.

Old Cairo has ſcarce any thing remarkable but the granaries of Joſeph; which are nothing but a high wall, lately built, which includes a ſquare ſpot of ground where they depoſit wheat, barley, and other grain, which is a tribute to the baſha, paid by the owners of land. This has no other covering but the heavens, and therefore the birds are always ſure to have their ſhare. There is likewiſe a tolerably handſome church, which is made uſe of by the Copts, who are Chriſtians and the original inhabitants of Egypt.

Joſeph's well is in the caſtle, and was made by King Mohammed about 700 years ago. It is called *Joſeph's well*, becauſe they attribute every thing extraordinary to that remarkable perſon. It is cut in a rock, and is 280 feet in depth. The water is drawn up to the top by means of oxen, placed on platforms, at proper diſtances, which turn about the machines that raiſe it. The deſcent is ſo ſloping, that, though there are no ſteps, the oxen can deſcend and aſcend with eaſe.

The river Nile, to which not only Cairo, but all Egypt is ſo much indebted, is now known to have its riſe in Abyſſinia. The increaſe of the Nile generally begins in May, and in June they commonly proclaim about the city how much it is riſen. Over againſt old Cairo the baſha has a houſe, wherein the water enters to a column, which has lines at the diſtance of every inch, and marks at every two feet as far as 30. When the water riſes to 22 feet, it is thought to be of a ſufficient height; when it riſes much higher, it does a great deal of miſchief. There is much pomp and ceremony uſed in letting the water into the canal above mentioned. See Egypt.

The inhabitants of Cairo are a mixture of Moors, Turks, Jews, Greeks, and Copts or Coptis. The only difference between the habit of the Moors and Coptis is their turbans; thoſe of the Moors being white, and of the Coptis white ſtriped with blue. The common people generally wear a long black looſe frock, ſewed together all down before. The Jews wear a frock of the ſame faſhion, made of cloth; and their caps are like a high-crowned hat, without brims, covered with the ſame cloth, but not ſo taper. The Jewiſh women's are not very unlike the men's, but more light and long. The Greeks are habited like the Turks, only their turbans differ.

Proviſions of all kinds are exceedingly plenty; for 20 eggs may be bought for a parah or penny, and bread is ſix times as cheap as with us. They have almoſt all ſorts of fleſh and fiſh; and in particular have tame buffaloes, which are very uſeful. They bring goats into the ſtreets in great numbers, to ſell their milk. Their gardens are well ſtocked with fruit trees of various kinds, as well as roots, herbs, melons, and cucumbers. The moſt common fleſh meat is mutton. The goats are very beautiful, and have ears two feet in length; but their fleſh is in no great eſteem. See farther the article Egypt.

CAIROAN, or Cairwan, a city of Africa, in the kingdom of Tunis, ſeated in a ſandy barren ſoil, about five miles from the gulf of Capres. It has neither ſpring, well, nor river; for which reaſon they are obliged to preſerve rain water in tanks and ciſterns. It was built by the Aglabites; and is the ancient Cyrene *, but hath now loſt its ſplendour. There is ſtill, however, a very ſuperb moſque, and the tombs of the kings of Tunis are yet to be ſeen. E. Long. 9. 12. N. Lat. 35. 40.

* See *Barbary*.

CAISSON, in the military art, a wooden cheſt, into which ſeveral bombs are put, and ſometimes filled only with gun-powder: this is buried under ſome work whereof the enemy intend to poſſeſs themſelves, and, when they are maſters of it, is fired, in order to blow them up.

Caisson is alſo uſed for a wooden frame or cheſt uſed in laying the foundations of the piers of a bridge.

CAITHNESS, otherwiſe called the *ſhire of Wick*, is the moſt northern county of all Scotland; bounded on the eaſt by the ocean, and by Strathnaver and Sutherland on the ſouth and ſouth-weſt: from theſe it is divided by the mountain of Orde, and a continued ridge of hills as far as Knockfin, then by the whole courſe of the river Hallowdale. On the north it is waſhed by the Pentland or Pictland frith, which flows between this county and the Orkneys. It extends 35 miles from north to ſouth, and about 20 from eaſt to weſt. The coaſt is rocky, and remarkable for a number of bays and promontories. Of theſe, the principal are Sandſide-head to the weſt, pointing to the opening of Pentland frith; Orcas, now Holborn-head, and Dunnet-head, both pointing northward to the frith. Dunnet-head is a peninſula about a mile broad, and ſeven in compaſs; affording ſeveral lakes, good paſture, excellent mill-ſtones, and a lead mine. Scribiſter bay, on the north-weſt is a good harbour, where ſhips may ride ſecurely. Rice-bay, on the eaſt ſide, extends three miles in breadth; but is of dangerous acceſs, on account of ſome ſunk rocks at the entrance. At the bottom of this bay appear the ruins of two ſtrong caſtles, the ſeat of the earl of Caithneſs, called *Caſtle Sinclair*, and Gernego, joined to each other by a draw-bridge. Duncan's bay, otherwiſe called *Dunſby-head*, is the north-eaſt point of Caithneſs, and the extremeſt promontory in Britain. At this place, the breadth of the frith does not exceed 12 miles, and in the neighbourhood is the ordinary ferry to the Orkneys. Here is likewiſe Clytheneſs pointing eaſt, and Noſhead pointing north-eaſt. The ſea in this place is very impetuous, being in continual agitation from violent counter tides, currents, and vortices. The only iſland belonging to this county is that of Stroma, in the Pentland frith, at the diſtance of two miles from the main land, extending about a mile in length, and producing good corn. The navigation is here rendered very difficult by conflicting tides and currents, which at both ends of the iſland produce a great agitation in the ſea. At the ſouth end, the waves dance ſo impetuouſly, that the ſailors term them the *merry men of May*, from the name of a gentleman's ſeat on the oppoſite ſhore of Caithneſs, which ſerved them as a land mark, in the dangerous paſſage between the iſland and the continent. The property of this iſland was once diſputed between the earls of Orkney and Caithneſs; but adjudged to the latter, in conſequence of an experiment, by which it appeared, that venomous creatures will live in Stroma, whereas they die immediately if tranſported to the Orkneys. The county of Caithneſs, though chiefly mountainous, flattens towards the ſea coaſt, where the ground is arable, and produces good harveſts of oats and barley, ſufficient for the natives, and yielding a ſurplus for exportation. Caithneſs is well watered with ſmall rivers, brooks, lakes, and fountains, and affords a few woods of birch, but is in general bare of trees; and even thoſe the inhabitants plant are ſtunted in their growth. Lead is found at Dunnet, copper at Old Urk, and iron ore at ſeveral places; but theſe advantages are not improved. The air of Caithneſs is temperate, though in the latitude of 58°, where the longeſt day in ſummer is computed at 18 hours; and when the ſun ſets, he makes

Caithneſs. ſo ſmall an arch of a circle below the horizon, that the people enjoy a twilight until he riſes again. The fuel uſed by the inhabitants of Caithneſs conſiſts of peat and turf, which the ground yields in great plenty. The foreſts of Morravins and Berridale afford abundance of red deer and roe-bucks; the county is well ſtored with hares, rabbits, growſe, heathcocks, plover, and all ſorts of game, comprehending a bird called *ſnow-fleet*, about the ſize of a ſparrow, exceedingly fat and delicious, that comes hither in large flights about the middle of February, and takes its departure in April. The hills are covered with ſheep and black cattle; ſo numerous, that a fat cow has been ſold at market for 4s. ſterling. The rocks along the coaſts are frequented by eagles, hawks, and all manner of ſea fowl, whoſe eggs and young are taken in vaſt quantities by the natives. The rivers and lakes abound with trout, ſalmon, and eels; and the ſea affords a very advantageous fiſhery. Divers obeliſks and ancient monuments appear in this diſtrict, and ſeveral Romiſh chapels are ſtill ſtanding. Caithneſs is well peopled with a race of hardy inhabitants, who employ themſelves chiefly in fiſhing, and breeding ſheep and black cattle: they are even remarkably induſtrious; for between Wick and Dunbeath, one continued tract of rugged rocks, extending 12 miles, they have forced ſeveral little harbours for their fiſhing boats, and cut artificial ſteps from the beach to the top of the rocks, where they have erected houſes, in which they cure and dry the fiſh for market.

According to Mr Pennant, this county is ſuppoſed to ſend out in ſome years about 20,000 head of black cattle, but in bad ſeaſons the farmer kills and ſalts great numbers for ſale. Great numbers of ſwine are alſo reared here. Theſe are ſhort, high backed, long briſtled, ſharp, ſlender, and long noſed; have long erect ears, and moſt ſavage looks. Here are neither barns nor granaries: the corn is threſhed out, and preſerved in the chaff in byks; which are ſtacks, in the ſhape of bee hives, thatched quite round, where it will keep good for two years. Vaſt numbers of ſalmon are taken at Caſtle-hill, Dunnet, Wick, and Thurſo. A miraculous draught at this laſt place is ſtill talked of, not leſs than 2500 being taken at one tide within the memory of man; and Mr Smollet inform us, that, in the neighbourhood, above 300 good ſalmon have been taken at one draught of the net. In the month of November, great numbers of ſeals are taken in the caverns that open into the ſea, and run ſome hundreds of yards under ground The entrance of theſe caverns is narrow, but the inſide lofty and ſpacious. The ſeal hunters enter theſe in ſmall boats with torches, which they light as ſoon as they land, and then with loud ſhouts alarm the animals, which they kill with clubs as they attempt to paſs. This is a hazardous employment; for ſhould the wind blow hard from ſea, theſe adventurers are inevitably loſt. Sometimes a large ſpecies of ſeals, 12 feet long, have been killed on this coaſt; and it is ſaid the ſame kind are found on the rock Hiſkir, one of the Weſtern iſlands. During the ſpring, great quantities of lump fiſh reſort to this coaſt, and are the prey of the ſeals, as appears from the number of ſkins of thoſe fiſhes which at that ſeaſon float aſhore. At certain times alſo the ſeals ſeem to be viſited by a great mortality; for, at thoſe times, multitudes of them are ſeen dead in the water. Much limeſtone is found in this county, which when burnt is made into a compeſt with turf and ſea plants.

The diſcovery of coal has long been an object of great importance in this part of Scotland. In the years 1801 and 1802 ſome attempts were made for this purpoſe at the expence of government. But although the buſineſs was conducted by perſons well ſkilled in ſuch matters, and long perſevered in, it has entirely failed, which leaves little hope of future ſucceſs.

The following is the population of the county of Caithneſs according to the pariſhes, taken at two different periods, namely in 1755 and in 1798, and extracted from the Statiſtical Hiſtory of Scotland.

Pariſh.	Population in 1755.	Population in 1790—1798.
Bower	1287	1592
Caniſby	1481	1950
Dunnet	1235	1399
Halkirk	3075	3180
Latheron	3675	4006
Olrick	875	1001
Reay	2262	2298
Thurſo	2963	3146
Wattin	1424	1230
Wick	3938	5000
	22,215	24,802
		22,215
		2,587

CAIUS, Kaye, or *Keye*, Dr John, the founder of Caius college in Cambridge, was born at Norwich in 1510. He was admitted very young a ſtudent in Gonville hall in the above-mentioned univerſity; and at the age of 21 tranſlated from Greek into Latin ſome pieces of divinity, and into Engliſh Eraſmns's paraphraſe on Jude, &c. From theſe his juvenile labours, it ſeems probable that he firſt intended to proſecute the ſtudy of divinity. Be that as it may, he travelled to Italy, and at Padua ſtudied phyſic under the celebrated Montanus. In that univerſity he continued ſome time, where we are told he read Greek lectures with great applauſe. In 1543, he travelled through part of Italy, Germany, and France; and returning to England commenced doctor of phyſic at Cambridge. He practiſed firſt at Shrewſbury, and afterwards at Norwich; but removing to London, in 1547, he was admitted fellow of the college of phyſicians, to which he was ſeveral years preſident. In 1557, being then phyſician to Queen Mary, and in great favour, he obtained a licenſe to advance Gonville-hall, where he had been educated, into a college; which he endowed with ſeveral conſiderable eſtates, adding an entire new ſquare at the expence of 1834l. Of this college he accepted the maſterſhip, which he kept till within a ſhort time of his death. He was phyſician to Edward VI. Queen Mary, and Queen Elizabeth. Towards the latter end of his life he retired to his own college at Cambridge; where, having reſigned the maſterſhip to Dr Legge of Norwich, he ſpent the remainder of his life as a fellow commoner. He died in July 1573, aged 63; and was buried in the chapel of his own college. Dr Caius was a learned, active, benevolent man. In 1557, he erected a monument in St Paul's to the memory of the famous Linacre. In 1563, he obtained a grant for the college of phyſicians to take the bodies of two malefactors annually for diſſection; and he was the inventor of the *inſignia* which diſtinguiſh the preſident from the reſt of the fellows. He wrote, 1. Annals of the college from 1555 to 1572. 2. Tranſlation of ſeveral of Galen's works. Printed at different times abroad. 3 *Hippocrates de Medicamentis*; firſt diſcovered and publiſhed by our author: alſo *De ratione victus*, Lov. 1556, 8vo. 4. *De Medendi Methodo*. Baſil, 1554. Lond. 1556, 8vo. 5. Account of the ſweating ſickneſs in England. Lond. 1556, 1721. It is entitled *De ephemera Britannica*. 6. Hiſtory of the univerſity of Cambridge. Lond. 1568, 8vo, 1574, 4to, in Latin. 7. *De thermis Britannicis*. Doubtful whether ever printed. 8. Of ſome rare plants and animals. Lond. 1570. 9. *De canibus Britannicis*, 1570, 1729. 10. *De pronunciatione Græcæ et Latinæ Linguæ*. Lond. 1574. 11. *De libris propriis*. Lond. 1570. Beſides many other works which never were printed.

CAKE, a finer ſort of bread, denominated from its flat round figure.

We meet with different compoſitions under the name of *cakes*; as *ſeed-cakes*, made of flour, butter, cream, ſugar, coriander, and caraway ſeeds, mace, and other ſpices and perfumes, baked in the oven; *plum-cake*, made much after the ſame manner, only with fewer ſeeds, and the addition of currants: *pan-cakes*, made of a mixture of flour, eggs, &c. fried; *cheeſe-cakes*, made of cream, eggs, and flour, with or without cheeſe-curd, butter, almonds, &c.; *oat-cakes*, made of fine oaten flour, mixed with yeſt and ſometimes without, rolled thin, and laid on an iron or ſtone to bake over a ſlow fire; *ſugar-cakes*, made of fine ſugar beaten and ſearced with the fineſt flour, adding butter, roſe-water, and ſpices; *roſe-cakes, (placentæ roſaceæ,)* are leaves of roſes dried and preſſed into a maſs, ſold in the ſhops for epithems.

The Hebrews had ſeveral ſorts of cakes, which they offered in the temple. They were made of the meal either of wheat or barley; they were kneaded ſometimes with oil and ſometimes with honey. Sometimes they only rubbed them over with oil when they were baked, or fried them with oil in a frying pan upon the fire. In the ceremony of Aaron's conſecration, they ſacrificed a calf and two rams, and offered unleavened bread, and cakes unleavened, tempered with oil, and wafers unleavened, anointed with oil; the whole made of fine wheaten flour. Ez. xxix. 1, 2.

CAKET, a town of Aſia, in Perſia, in the province of Curdiſtan near Mount Caucaſus. Its trade conſiſts chiefly in ſilks. E. Long. 46. 15. N. Lat. 43. 32.

CALABASH, in commerce, a light kind of veſſel formed of the ſhell of a gourd, emptied and dried, ſerving to put divers kinds of goods in, as pitch, roſin, and the like. The word is Spaniſh, *Calabacca*, which ſignifies the ſame. The Indians alſo, both of the North and South Sea, put the pearls they have fiſhed in calabaſhes, and the negroes on the coaſt of Africa do the ſame by their gold duſt. The ſmaller calabaſhes are alſo frequently uſed by theſe people as a meaſure, by which they ſell theſe precious commodities to the Europeans. The ſame veſſels likewiſe ſerve for putting liquors in; and do the office of cups, as well as bottles, for ſoldiers, pilgrims, &c.

Calabash-Tree. See Crescentia, Botany *Index*.

African Calabash-Tree. See Adansonia, Botany *Index*.

CALABRIA, a country of Italy, in the kingdom of Naples, divided into Calabria Ultra, and Calabria Citra, commonly called *Ulterior* and *Citerior*, or Farther and Hither Calabria. Calabria Citerior is one of the 12 provinces of the kingdom of Naples; and bounded on the ſouth by Calabria Ultra, on the north by Baſilicata, and on the weſt and eaſt by the ſea: Coſenſa is the capital. Calabria Ultra is waſhed by the Mediterranean ſea on the eaſt, ſouth, and weſt, and bounded by Calabria Citra on the north. Reggio is the capital town.

This country has been almoſt entirely deſolated by the earthquakes of 1783. The reiterated ſhocks extended from Cape Spartivento to Amantea above the gulf of St Eufemia, and alſo affected that part of Sicily which lies oppoſite to the ſouthern extremity of Italy. Thoſe of the 5th and 7th of February, and of the 28th of March, were the moſt violent, and completed the deſtruction of every building throughout the above-mentioned ſpace. Not one ſtone was left upon another ſouth of the narrow iſthmus of Squillace: and what is more diſaſtrous, a very large proportion of the inhabitants was killed by the falling of their houſes, near 40,000 lives being loſt. Some perſons were dug out alive after remaining a ſurpriſing length of time buried among the rubbiſh. Meſſina became a maſs of ruins; its beautiful palazzata was thrown in upon the town, and its quay cracked into ditches full of water. Reggio was almoſt deſtroyed; Tropea greatly damaged; and every other place in the province levelled to the ground.

Before and during the concuſſion the clouds gathered, and then hung immoveable and heavy over the earth. At Palmi the atmoſphere wore ſo fiery an aſpect, that many people thought part of the town was burning. It was afterwards remembered that an unuſual heat had affected the ſkins of ſeveral perſons juſt before the ſhock; the rivers aſſumed a muddy aſh-coloured tinge, and a ſulphureous ſmell was almoſt general. A frigate paſſing between Calabria and Lipari felt ſo ſevere a ſhock, that the ſteerſman was thrown from the helm, and the cannons were raiſed upon their carriages, while all around the ſea exhaled a ſtrong ſmell of brimſtone.

Stupendous alterations were occaſioned in the face of the country; rivers choked up by the falling in of the hills, were converted into lakes, which if not ſpeedily drained by ſome future convulſion, or opened by human labour, will fill the air with peſtilential vapours, and deſtroy the remnants of population. Whole acres of ground, with houſes and trees upon them, were broken off from the plains, and waſhed many furlongs down the deep hollows which the courſe of the rivers had worn; there, to the aſtoniſhment and terror of beholders, they found a new foundation to fix upon, either in an upright or an inclining poſition. In ſhort, every ſpecies of phenomenon, incident to theſe deſtructive commotions of the earth, was to be ſeen in its utmoſt extent and variety in this deſolated country. Their Sicilian majeſties, with the utmoſt expedition, deſpatched veſſels loaded with every thing that could be thought of on the occaſion for the relief and accommodation of the diſtreſſed Calabrians; a general officer went from Naples with engineers and troops to direct the operations of the perſons employed in clearing away and rebuilding the houſes, and to defend the property of the ſufferers. The king ordered this officer to take all the money the royal treaſures could ſupply or borrow; for, rather than it ſhould be wanting on this preſſing call, he was determined to part with his plate, nay the very furniture of his palace. A meſſenger ſent off from a town near Reggio, on the 8th of February, travelled four days without ſhelter, and without being able to procure a morſel of bread; he ſupported nature with a piece of cheeſe which he had brought in his pocket, and the vegetables he was lucky enough to find near the road. To add to all their other ſufferings, the Calabrians found themſelves and the miſerable wreck of their fortunes expoſed to the depredations of robbers and pirates. Villains landed from boats, and plundered ſeveral places, and thieves went even from Naples in ſearch of booty: In order to ſtrike a greater terror, they dreſſed themſelves like Algerines; but were diſcovered, and driven off. To this accumulated diſtreſs ſucceeded a moſt inclement ſeaſon, which obſtructed every effort made to alleviate it; and almoſt daily earthquakes kept the inhabitants in continual dread, not of being deſtroyed by the fall of houſes, for none were left, but of being ſwallowed up by the ſplitting of the earth, or buried in the waves by ſome ſudden inundation.

For further particulars concerning this dreadful cataſtrophe, and the phenomena attending it, ſee EARTHQUAKE.

CALADE, in the manege, the deſcent or ſloping declivity of a riſing manege ground, being a ſmall eminence upon which we ride down a horſe ſeveral times, putting him to a ſhort gallop, with his fore hams in the air, to learn him to ply or bend his haunches, and form his ſtop upon the aides of the calves of the legs, the ſtay of the bridle, and the caveſon ſeaſonably given.

CALAGORINA, or CALAGURIS, diſtinguiſhed by the ſurname *Naſica*, in *Ancient Geography*, a city of the Vaſcones in the Hither Spain: now *Calahorra*.

CALAHORRA, an epiſcopal town of Spain, in Old Caſtile, ſeated on a fertile ſoil, on the ſide of a hill which extends to the banks of the river Ebro. W. Long. 2. 7. N. Lat. 42. 12.

CALAIS, a ſtrong town of France, in Lower Picardy, now called the department of the ſtraits of Calais, which has a citadel and a fortified harbour. It is built in the form of a triangle, one ſide of which is towards the ſea. The citadel is as large as the town, and has but one entrance. It is a trading place, with handſome ſtreets, and ſeveral churches and monaſteries; the number of inhabitants is reckoned to be 4000.

Calais was taken by Edward III. in 1347. Hither he marched his victorious army from Creſſy, and inveſted the town on the 8th of September. But finding that it could not be taken by force without the deſtruction of great multitudes of his men, he turned the ſiege into a blockade; and having made ſtrong intrenchments to ſecure his army from the enemy, huts to protect them from the inclemency of the weather, and ſtationed a fleet before the harbour, to prevent the introduction of proviſions, he reſolved to wait with patience till the place fell into his hands by famine. The beſieged, diſcovering his intention, turned ſeventeen hundred women, children, and old people, out of the town, to ſave their proviſions; and Edward had the goodneſs, after entertaining them with a dinner, and giving them two-pence a piece, to ſuffer them to paſs. The garriſon and inhabitants of Calais having at length conſumed all their proviſions, and even eaten all the horſes, dogs, cats, and vermine in the place, the governor John de Vienne appeared upon the walls, and offered to capitulate. Edward, greatly incenſed at their obſtinate reſiſtance, which had detained him eleven months under their walls, at an immenſe expence, both of men and money, ſent Sir Walter Mauny, an illuſtrious knight, to acquaint the governor that he would grant them no terms; but that they muſt ſurrender at diſcretion. At length, however, at the ſpirited remonſtrances of the governor, and the perſuaſions of Sir Walter Mauny, Edward conſented to grant their lives to all the garriſon and inhabitants, except ſix of the principal burgeſſes, who ſhould deliver to him the keys of the city, with ropes about their necks. When theſe terms were made known to the people of Calais, they were plunged into the deepeſt diſtreſs; and after all the miſeries they had ſuffered, they could not think without horror of giving up ſix of their fellow citizens to certain death. In this extremity, when the whole people were drowned in tears, and uncertain what to do, Euſtace de St Pierre, one of the richeſt merchants in the place, ſtepped forth, and voluntarily offered himſelf to be one of theſe ſix devoted victims. His noble example was ſoon imitated by other five of the moſt wealthy citizens. Theſe true patriots, barefooted, and bareheaded, with ropes about their necks, were attended to the gates by the whole inhabitants, with tears, bleſſings, and prayers for their ſafety. When they were brought into Edward's preſence, they laid the keys of the city at his feet, and, falling on their knees, implored his mercy in ſuch moving ſtrains, that all the noble ſpectators melted into tears. The king's reſentment was ſo ſtrong for the many toils and loſſes he had ſuffered in this tedious ſiege, that he was in ſome danger of forgetting his uſual humanity; when the queen, falling upon her knees before him, earneſtly begged and obtained their lives. This great and good princeſs conducted theſe virtuous citizens, whoſe lives ſhe had ſaved, to her own apartment, entertained them honourably, and diſmiſſed them with preſents. Edward took poſſeſſion of Calais Auguſt 4th; and in order to ſecure a conqueſt of ſo great importance, and which had coſt him ſo dear, he found it neceſſary to turn out all the ancient inhabitants, who had diſcovered ſo ſtrong an attachment to their native prince, and to people it with Engliſh.

Calais remained in ſubjection to England till the reign of Queen Mary, when it was retaken by the duke of Guiſe. This general began the enterpriſe by ordering the privateers of Normandy and Bretagne to cruiſe in the Channel, more eſpecially in the very ſtraits of Calais: he then detached the duke of Nevers with a conſiderable army towards the country of Luxemburg; a motion which drew the attention of the Spaniards that way: when all things were ready, he procured an application from the people of Boulogne, for a body of troops to ſecure them againſt the incurſions of the Spaniards; he ſent a ſtrong detachment at their requeſt, which was followed by another, under colour of ſupporting them; then repaired thither in perſon, ſecure that his officers would follow his inſtructions: and thus, on the firſt day of the new year, 1557, Calais was inveſted. He immediately attacked Fort St Agatha, which the garriſon quitted, and retired into the fort of Nicolai, which, together with the Riſbank, the beſiegers attacked at the ſame time, granted good terms to the officer who commanded in the former, but obliged the garriſon of the latter to ſurrender priſoners of war. By theſe means he opened a communication with the ſea; and having received from on board the ſhips an immenſe quantity of hurdles, his infantry, by the help of them, paſſed the moraſſes that lie round the town. He then made a falſe attack at the water-gate, which drew the attention of the garriſon, who fatigued themſelves exceedingly in making intrenchments behind the breach; but when they had finiſhed their work, he began to fire upon the caſtle, where the walls were very old, and had been neglected on account of the breadth of the ditch, which was alſo very deep when the tide was in; but a great breach being made, the duke cauſed it to be attacked in the night, and during the ebb, the ſoldiers paſſing almoſt up to the ſhoulders. The place was eaſily carried, though the governor made three vigorous attacks before the break of day, in order to diſlodge them; but the French, though they loſt a conſiderable number of men, kept their poſts. The governor then ſaw that it was impracticable to defend the place any longer, and therefore made the beſt terms for himſelf that he could obtain, which, however, were not very good: and thus in eight days the duke of Guiſe recovered a fortreſs which coſt the victorious Edward III. a whole year's ſiege, and which had been now 210 years in the poſſeſſion of the Engliſh, without ſo much as a ſingle attempt to retake it. There are very different accounts given of this matter. Some Engliſh hiſtorians ſay, that King Philip penetrated the deſign of the French upon this fortreſs, gave notice of it in England, and offered to take the defence of it upon himſelf; but that this, out of jealouſy, was refuſed, it being believed to be only an artifice to get a place of ſuch conſequence into his own hands. The truth of the matter ſeems to be this: The ſtrength of Calais conſiſted in its ſituation and outworks, which required a very numerous garriſon; but this being attended with a very large expence, the beſt part of the troops had been ſent to join Philip's army, ſo that the governor had not above 500 men, and there were no more than 250 of the townſmen able to bear arms. As to ammunition, artillery, and proviſions, the French found there abundance: but with ſo ſlender a garriſon, it was impoſſible to make a better defence; and therefore when the Lord Wentworth, who was governor, and whom the French call Lord Dumfort, was tried by his peers for the loſs of this place, he was acquitted. The duke obliged all the Engliſh inhabitants to quit Calais; and beſtowed the government of it upon Des Termes, who was ſoon after made a marſhal of France.

The fortifications of Calais are good; but its greateſt ſtrength is its ſituation among the marſhes, which may be overflowed at the approach of an enemy. The harbour is not ſo good as formerly, nor will it admit veſſels of any great burden. In times of peace, there are packet boats going backward and forward twice a week from Dover to Calais, which is 21 miles diſtant. E. Long. 2. 6. N. Lat. 50. 58.

Calais *and Zetes*, in fabulous hiſtory, ſons of Boreas and Orythia, to whom the poets attributed wings: they went on the voyage to Colchis with the Argonauts; delivered Phineus from the harpies; and were ſlain by Hercules.

CALAMANCO, a ſort of woolen ſtuff manufactured in England and Brabant. It has a fine gloſs; and is checkered in the warp, whence the checks appear only on the right ſide. Some calamancoes are quite plain, others have broad ſtripes adorned with flowers, ſome with plain broad ſtripes, ſome with narrow ſtripes, and others watered.

CALAMARIÆ, in *Botany*, an order of plants in the *Fragmenta methodi naturalis* of Linnæus; in which he has the following genera, viz. bobartia, ſcirpus, cyperus, eriophorum, carex, ſchœnus, flagellaria, juncus. See Botany.

CALAMATA, a conſiderable town of Turkey in Europe, in the Morea, and province of Belvidera. It was taken by the Venetians in 1685; but the Turks retook it afterwards with all the Morea. It ſtands on the river Spinarza, eight miles from the ſea. E. Long. 22. 15. N. Lat. 37. 8.

CALAMINE, Calamy, *Lapis Calaminaris* or *Cadmia Foſſilis*, a ſort of ſtone or mineral containing zinc, iron, and ſometimes other ſubſtances. It is conſiderably heavy; moderately hard and brittle, or of a conſiſtence betwixt ſtone and earth: the colour ſometimes whitiſh or gray; ſometimes yellowiſh, or of a deep yellow; ſometimes red; ſometimes brown or blackiſh. It is plentiful in ſeveral places of Europe, as Hungary, Tranſylvania, Poland, Spain, Sweden, Bohemia, Saxony, Goſlar, France, and England, particularly in Derbyſhire, Glouceſterſhire, Nottinghamſhire, and Somerſetſhire, as alſo in Wales. The calamine of England, however, is by the beſt judges allowed to be ſuperior in quality to that of moſt other countries. It ſeldom lies very deep, being chiefly found in clayey grounds near the ſurface. In ſome places it is mixed with lead ores. It is a true ore of zinc, and is uſed as an ingredient in making of braſs.—Newman relates various experiments with this mineral, the only reſult of which was to ſhow that it contained iron as well as zinc. The moſt remarkable are the following: A ſaturated ſolution of calamine in the marine acid, concentrated by evaporating part of the liquor, exhibits in the cold an appearance of fine cryſtals, which on the application of warmth diſſolve and diſappear. A little of this concentrated ſolution tinges a large quantity of water of a bright yellow colour; and at the ſame time depoſites by degrees a fine, ſpongy, browniſh precipitate. Blue diſſolved in this ſolution, and afterwards inſpiſſated, forms an extremely ſlippery tenacious maſs, which does not become dry, and, were it not too expenſive, might be of uſe for entangling flies, caterpillars, &c. Sulphur boiled in this ſolution, ſeems to acquire ſome degree of tranſparency.—This mineral is an article in the materia medica; but, before it comes to the ſhops is uſually roaſted or calcined, in order to ſeparate ſome arſenical or ſulphureous matter which in its crude ſtate it is ſuppoſed to contain, and to render it more eaſily reducible into a fine powder. In this ſtate it is employed in collyria againſt defluxions of thin acrid humours upon the eyes, for drying up moiſt running ulcers, and healing excoriations. It is the baſis of an officinal epulotic Cerate.

This is another ſubſtance from which this ſemimetal is alſo obtained. This is called *cadmia fornacum*, or *cadmia of the furnaces*, to diſtinguiſh it from the other. This is a matter ſublimed when ores containing zinc, like thoſe of Rammelſberg, are ſmelted. This cadmia conſiſts of the flowers of the ſemi-metal ſublimed during the fuſion, and adhering to the inner ſurfaces of the walls of furnaces, where they ſuffer a ſemi-fuſion, and therefore acquire ſome ſolidity. So great a quantity of theſe is collected, that they form very thick incruſtations, which muſt be frequently taken off.

CALAMINT. See Melissa and Mentha, Botany *Index*.

CALAMUS. See Botany *Index*. There is but one ſpecies, the rotang. The ſtem is without branches, has a crown at top, and is everywhere beſet with ſtraight ſpines. This is the true Indian cane, which is not viſible on the outſide; but the bark being taken off diſcovers the ſmooth ſtick, which has no marks of ſpine on the bark, and is exactly like thoſe which the Dutch ſell to us; keeping this matter very ſecret, leſt travellers going by ſhould take as many canes out of the woods as they pleaſe. Sumatra is ſaid to be the place where moſt of theſe ſticks grow. Such are to be choſen as are of proper growth between two joints, ſuitable to the faſhionable length of canes as they are then worn; but ſuch are ſcarce. The calamus rotang is one of ſeveral plants from which the drug called *dragons blood* is obtained.

Calamus, in the ancient poets, denotes a ſimple kind of pipe or fiſtula, the muſical inſtrument of the ſhepherds and herdſmen; uſually made either of an oaten ſtalk or a reed.

Calamus *Aromaticus*, or *Sweet-ſcented Flag*, in the materia medica, a ſpecies of flag called *acorus* by Linnæus. See Acorus. Botany *Index*.

Calamus *Scriptorius*, in antiquity, a reed or ruſh to write with. The ancients made uſe of ſtyles to write on tables covered with wax; and of reed, or ruſh, to write on parchment, or Egyptian paper.

CALAMY Edmund, an eminent Preſbyterian divine, born at London in the year 1600, and educated at Pembroke-hall, Cambridge, where his attachment to the Arminian party excluded him from a fellowſhip. Dr Felton biſhop of Ely, however, made him his chaplain; and, in 1639, he was choſen miniſter of St Mary Aldermary, in the city of London. Upon the opening of the long parliament, he diſtinguiſhed himſelf in defence of the preſbyterian cauſe; and had a principal hand in writing the famous *Smectymnus*, which, himſelf ſays, gave the firſt deadly blow to Epiſcopacy. The authors of this tract were five, the initials of whoſe names formed the name under which it was publiſhed; viz. Stephen Marſhal, Edmund Calamy, Thomas Young, Mathew Newcomen, and William Sparſtow. He was after that an active member in the aſſembly of divines, was a ſtrenuous oppoſer of ſectaries, and uſed his utmoſt endeavours to prevent thoſe violences committed after the king was brought from the iſle of Wight. In Cromwell's time, he lived privately, but was aſſiduous in promoting the king's return; for which he was afterwards offered a biſhopric, but refuſed it. He was ejected for nonconformity in 1662; and died of grief at the ſight of the great fire of London.

Calamy, *Edmund*, grandſon to the preceding, (by his eldeſt ſon, Mr Edmund Calamy, who was ejected from the living of Moxton in Eſſex on St Bartholomew's day 1662) was born in London, April 5. 1671. After having learned the languages, and gone through a courſe of natural philoſophy and logic at a private academy in England he ſtudied philoſophy and civil law at the univerſity of Utrecht, and attended the lectures of the learned Grævius. Whilſt he reſided here, an offer of a profeſſor's chair in the univerſity of Edinburgh was made him by Mr Carſtairs, principal of that univerſity, ſent over on purpoſe to find a perſon properly qualified for ſuch an office. This he declined; and returned to England in 1691, bringing with him letters from Grævius to Dr Pococke canon of Chriſt-church and regius profeſſor of Hebrew, and to Dr Bernard, Savilian profeſſor of aſtronomy, who obtained leave for him to proſecute his ſtudies in the Bodleian library. Having reſolved to make divinity his principal ſtudy, he entered into an examination of the controverſy between the conformiſts and nonconformiſts; which determined him to join the latter; and coming to London in 1692, he was unanimouſly choſen aſſiſtant to Mr Matthew Sylveſter at Blackfriars: and in 1694, he was ordained at Mr Anneſty's meeting-houſe in Little St Helena, and ſoon after was invited to become aſſiſtant to Mr Daniel Williams in Hand-Alley. In 1702, he was choſen to be one of the lecturers in Salters-hall; and in 1703, ſucceeded Mr Vincent Alſop as paſtor of a great congregation in Weſtminſter. He drew up the table of contents to Mr Baxter's hiſtory of his life and times, which was ſent to the preſs in 1696; made ſome remarks on the work itſelf, and added to it an index; and, reflecting on the uſefulneſs of the book, he ſaw the expediency of continuing it, for Mr Baxter's hiſtory came no lower than the year 1684. Accordingly he compoſed an abridgement of it, with an account of many other miniſters who were ejected after the reſtoration of Charles II.; their apology, containing the grounds of their nonconformity and practice as to ſtated and occaſional communion with the church of England; and a continuation of their hiſtory till the year 1691. This work was publiſhed in 1702. He afterwards publiſhed a moderate defence of nonconformity, in three tracts, in anſwer to ſome tracts of Dr Hoadley. In 1709, Mr Calamy made a tour to Scotland; and had the degree of doctor of divinity conferred on him by the univerſities of Edinburgh, Aberdeen, and Glaſgow. In 1713, he publiſhed a ſecond edition of his Abridgement of Mr Baxter's hiſtory of his life and times; in which, among other additions, there is a continuation of the hiſtory through King William's reign, and Queen Anne's, down to the paſſing of the occaſional bill; and in the cloſe is ſubjoined the reformed liturgy, which was

drawn

Calandre, Calas.

drawn up and preſented to the biſhops in 1661, "that the world may judge (he ſays in his preface) how fairly the ejected miniſters have been often repreſented as irreconcilable enemies to all liturgies." In 1718, he wrote a vindication of his grandfather, and ſeveral other perſons, againſt certain reflections caſt upon them by Mr Archdeacon Echard in his Hiſtory of England; and in 1728 appeared his Continuation of the account of the miniſters, lecturers, maſters, and fellows of colleges, and ſchoolmaſters, who were ejected, after the reſtoration in 1660, by or before the act of uniformity. He died June 3, 1732, greatly regretted not only by the diſſenters, but alſo by the moderate members of the eſtabliſhed church, both clergy and laity, with many of whom he lived in great intimacy. Beſides the pieces already mentioned, he publiſhed a great many ſermons on ſeveral ſubjects and occaſions. He was twice married, and had 13 children.

CALANDRE, a name given by the French writers to an inſect that does vaſt miſchief in granaries. It is properly of the ſcarab or beetle claſs; it has two antennæ or horns formed of a great number of round joints, and covered with a ſoft and ſhort down; from the anterior part of the head there is thruſt out a trunk, which is ſo formed at the end, that the creature eaſily makes way with it through the coat or ſkin that covers the grain, and gets at the meal or farina on which it feeds; the inſide of the grains is alſo the place where the female depoſites her eggs, that the young progeny may be born with proviſion about them. When the female has pierced a grain of corn for this purpoſe, ſhe depoſites in it one egg, or at the utmoſt two, but ſhe moſt frequently lays them ſingle: theſe eggs hatch into ſmall worms, which are uſually found with their bodies rolled up in a ſpiral form, and after eating till they arrive at their full growth, they are changed into chryſales, and from theſe in about a fortnight comes out the perfect calandre. The female lays a conſiderable number of eggs; and the increaſe of theſe creatures would be very great, but nature has ſo ordered it, that while in the egg ſtate, and even while in that of the worm, they are ſubject to be eaten by mites: theſe little vermine are always very plentiful in granaries, and they deſtroy the far greater number of theſe larger animals.

CALAS, John; the name of a moſt unfortunate Proteſtant merchant at Thoulouſe, inhumanly butchered under forms of law cruelly proſtituted to ſhelter the ſanguinary dictates of ignorant Popiſh zeal. He had lived 40 years at Thoulouſe. His wife was an Engliſh woman of French extraction: and they had five ſons, one of whom, Lewis, had turned Catholic through the perſuaſions of a Catholic maid who had lived 30 years in the family. In October 1761, the family conſiſted of Calas, his wife, Mark Anthony their ſon, Peter their ſecond ſon, and this maid. Anthony was educated for the bar; but being of a melancholy turn of mind, was continually dwelling on paſſages from authors on the ſubject of ſuicide, and one night in that month hanged himſelf on a bar laid acroſs two folding doors in their ſhop. The crowd collected by the confuſion of the family on ſo ſhocking a diſcovery, took it into their heads that he had been ſtrangled by the family to prevent his changing his religion, and that this was a common practice among Proteſtants. The officers of juſtice adopted the popular tale, and were ſupplied by the mob with what they accepted as evidences of the fact. The fraternity of White Penitents got the body, buried it with great ceremony, and performed a ſolemn ſervice for him as a martyr: the Franciſcans did the ſame; and after theſe formalities no one doubted the guilt of the devoted heretical family. They were all condemned to the torture, to bring them to confeſſion: they appealed to the parliament; who, as weak and as wicked as the ſubordinate magiſtrate, ſentenced the father to the torture, ordinary and extraordinary, to be broken alive upon the wheel, and then to be burnt to aſhes. A diabolical decree! which, to the ſhame of humanity, was actually carried into execution. Peter Calas, the other ſon, was baniſhed for life; and the reſt were acquitted. The diſtracted widow found ſome friends, and among the reſt M. Voltaire, who laid her caſe before the council of ſtate at Verſailles, and the parliament of Thoulouſe was ordered to tranſmit the proceedings. Theſe the king and council unanimouſly agreed to annul; the capitoul or chief magiſtrate of Thoulouſe was degraded and fined; old Calas was declared to have been innocent; and every imputation of guilt was removed from the family, who alſo received from the king and clergy conſiderable gratuities.

Calash, Calasio.

CALSH, or Calesh, a ſmall light kind of chariot or chair, with very low wheels, uſed chiefly for taking the air in parks and gardens. The calaſh is for the moſt part richly decorated, and open on all ſides for the conveniency of the air and proſpect, or at moſt encloſed with light mantlets of wax-cloth to be opened and ſhut at pleaſure. In the Philoſophical Tranſactions we have a deſcription of a new ſort of calaſh going on two wheels, not hung on traces, yet eaſier than the common coaches, over which it has this further advantage, that whereas a common coach will overturn if one wheel go on a ſurface a foot and a half higher than the other, this will admit of a difference of 3½ feet without danger of overturning. Add, that it would turn over and over; that is, after the ſpokes being ſo turned as that they are parallel to the horizon, and one wheel flat over the head of him that rides in it, and the other flat under him, it will turn once more, by which the wheels are placed *in ſtatu quo*, without any diſorder to the horſe or rider.

CALASIO, Marius, a Franciſcan, and profeſſor of the Hebrew language at Rome, of whom there is very little to be ſaid, but that he publiſhed there, in the year 1621, a Concordance of the Bible, which conſiſted of four great volumes in folio. This work has been highly approved and commended both by Proteſtants and Papiſts, and is indeed a moſt admirable work. For beſides the Hebrew words in the Bible, which are in the body of the book, with the Latin verſion over againſt them; there are, in the margin, the differences between the Septuagint verſion and the Vulgate; ſo that at one view may be ſeen wherein the three Bibles agree, and wherein they differ. Moreover, at the beginning of every article there is a kind of dictionary, which gives the ſignification of each Hebrew word; affords an opportunity of comparing it with other oriental languages, viz. with the Syriac, Arabic, and Chaldee; and is extremely uſeful for determining more exactly the true meaning of the Hebrew words.

CALASIRIS, in antiquity, a linen tunic fringed at the bottom, and worn by the Egyptians under a white woollen garment: but this laſt they were obliged to pull off when they entered the temples, being only allowed to appear there in linen garments.

CALATAJUD, a large and handſome town of Spain, in the kingdom of Arragon; ſituated at the confluence of the rivers Xalon and Xiloca, at the end of a very fertile valley, with a good caſtle on a rock. W. Long. 2. 9. N. Lat. 41. 22.

CALATHUS, in antiquity, a kind of hand baſket made of light wood or ruſhes; uſed by the women ſometimes to gather flowers, but chiefly after the example of Minerva to put their work in. The figure of the calathus, as repreſented on ancient monuments, is narrow at the bottom, and widening upwards like that of a top. Pliny compares it to that of a lily. The calathus or work baſket of Minerva is no leſs celebrated among the poets than her diſtaff.

CALATHUS was alſo the name of a cup for wine uſed in ſacrifices.

CALATOR, in antiquity, a crier, or officer appointed to publiſh ſome thing aloud, or call the people together. The word is formed from καλεω, *voco, I call.* Such miniſters the pontifices had, whom they uſed to ſend before them when they went to ſacrifice on *feriæ* or holidays, to advertiſe the people to leave off work. The magiſtrates alſo uſed *calatores*, to call the people to the comitia, both *curiata* and *centuriata.* The officers in the army alſo had *calatores*; as had likewiſe many private families, to invite their gueſts to entertainments.

CALATRAVA, a city of New Caſtile, in Spain, ſituated on the river Guadiana, 45 miles ſouth of Toledo. W. Long. 4. 20. N. Lat. 39. 0.

Knights of CALATRAVA, a military order in Spain, inſtituted by Sancho III. king of Caſtile, upon the following occaſion: When that prince took the ſtrong fort of Calatrava from the Moors of Andaluſia, he gave it to the Templars, who, wanting courage to defend it, returned it him again. Then Don Reymond of the order of the Ciſtercians, accompanied with ſeveral perſons of quality, made an offer to defend the place, which the king thereupon delivered up to them, and inſtituted that order. It increaſed ſo much under the reign of Aſphonſus, that the knights deſired they might have a grand maſter, which was granted. Ferdinand and Iſabella afterwards, with the conſent of Pope Innocent VIII. re-united the grand maſterſhip of Calatrava to the Spaniſh crown; ſo that the kings of Spain are now become perpetual adminiſtrators thereof.

The knights of Calatrava bear a croſs gules, fleurdeliſed with green, &c. Their rule and habit was originally that of the Ciſtercians.

CALAURIA, in *Ancient Geography*, an iſland of Greece in the Saronic bay, over againſt the port of Troezen, at the diſtance of 40 ſtadia. Hither Demoſthenes went twice into baniſhment; and here he died. Neptune was ſaid to have accepted this iſland from Apollo, in exchange for Delos. The city ſtood on a high ridge nearly in the middle of the iſland, commanding an extenſive view of the gulf and its coaſts. There was his holy temple. The prieſteſs was a virgin, who was diſmiſſed when marriageable. Seven of the cities near the iſland held a congreſs at it, and ſacrificed jointly to the deity. Athens, Ægina, and Epidaurus, were of this number, with Nauplias, for which place Argos contributed. The Macedonians, when they had reduced Greece, were afraid to violate the ſanctuary, by forcing from it the fugitives, his ſuppliants. Antipater commanded his general to bring away the orators, who had offended him, alive; but Demoſthenes could not be prevailed on to ſurrender. His monument remained in the ſecond century, within the encloſure of the temple. The city of Calauria has been long abandoned. Traces of buildings and of ancient walls appear nearly level with the ground; and ſome ſtones in their places, each with a ſeat and back forming a little circle, once perhaps a bath. The temple, which was of the Doric order, and not large, as may be inferred from the fragments, is reduced to an inconſiderable heap of ruins. The iſland is now called *Poro.* It ſtretches along before the coaſt of the Morea in a lower ridge, and is ſeparated from it by a canal only four ſtadia, or half a mile wide. This which is called Poro or the Ferry, in ſtill weather may be paſſed on foot, as the water is not deep. It has given its name to the iſland; and alſo to the town, which conſiſts of about 200 houſes, mean and low, with flat roofs; riſing on the ſlope of a bare diſagreeable rock.

CALCADA, or *St Domingo* CALCALDA, a town of Spain, ſituated in W. Long. 3. 5. N. Lat. 42. 36.

CALCAR, a very ſtrong town of Germany, in the circle of Weſtphalia, and duchy of Cleves. It belongs to the king of Pruſſia, and is ſeated near the Rhine, in E. Long. 5. 41. N. Lat. 51. 45.

CALCAR, in glaſs-making, the name of a ſmall oven or reverberatory furnace, in which the firſt calcination of ſand and ſalt of potaſhes is made for the turning them into what is called *frit.* This furnace is made in the faſhion of an oven, ten feet long, ſeven broad in the wideſt part, and two feet deep. On one ſide of it is a trench ſix inches ſquare, the upper part of which is level with the calcar, and ſeparated only from it at the mouth by bricks nine inches wide. Into this trench they put ſea-coal, the flame of which is carried into every part of the furnace, and is reverberated from the roof upon the frit, over the ſurface of which the ſmoke flies very black, and goes out at the mouth of the calcar; the coals burn on iron grates, and the aſhes fall through.

CALCAR, *John de*, a celebrated painter, was the diſciple of Titian, and perfected himſelf by ſtudying Raphael. Among other pieces he drew a Nativity, repreſenting the angels around the infant Chriſt; and ſo ordered the diſpoſition of his picture, that the light all proceeds from the Child. He died at Naples, in 1546, in the flower of his age. It was he who deſigned the anatomical figures of Veſal, and the portraits of the painters of Veſari.

CALCAREOUS, ſomething that partakes of the nature and qualities of calx, or lime. We ſay, a *calcareous* earth, *calcareous* ſtone. See CHEMISTRY *Index.*

CALCEARIUM, in antiquity, a donative or largeſs beſtowed on Roman ſoldiers for buying ſhoes. In monaſteries, *calcearium* denoted the daily ſervice of cleaning the ſhoes of the religious.

CALCEOLARIA. See BOTANY *Index*.

CALCHAS, in fabulous hiſtory, a famous diviner, followed the Greek army to Troy. He foretold that the ſiege would laſt ten years: and that the fleet, which was detained in the port of Aulis by contrary winds, would not ſail till Agamemnon's daughter had been ſacrificed to Diana. After the taking of Troy, he retired to Colophon; where, it is ſaid, he died of grief, becauſe he could not divine what another of his profeſſion, called *Mopſus*, had diſcovered.

CALCINATION, in *Chemiſtry*, the reducing of ſubſtances to a calx, or powder, by fire. Limeſtone is ſaid to be calcined or burned by being deprived of its carbonic acid, and thus brought to the cauſtic ſtate. But when a metallic ſubſtance is calcined by being expoſed to ſtrong heat, it aſſumes the form of powder or calx, by combining with oxygen. See CHEMISTRY *Index*.

CALCINATO, a town of Italy, in the duchy of Mantua, remarkable for a victory gained over the Imperialiſts by the French in 1706. E. Long. 9. 55. N. Lat. 45. 25.

CALCULARY *of a* PEAR, a congeries of little ſtrong knots diſperſed through the whole parenchyma of the fruit. The calculary is moſt obſerved in rough-taſted or choke pears. The knots lie more continuous and compact together towards the pear where they ſurround the ACETARY. About the ſtalk they ſtand more diſtant; but towards the cork, or ſtool of the flower, they ſtill grow cloſer, and there at laſt gather into the firmneſs of a plum ſtone. The calculary is no vital or eſſential part of the fruit; the ſeveral knots whereof it conſiſts being only ſo many concretions or precipitations out of the ſap, as we ſee in urines, wines, and other liquors.

CALCULATION, the act of computing ſeveral ſums, by adding, ſubtracting, multiplying, or dividing. See ARITHMETIC.

CALCULATION is more particularly uſed to ſignify the computations in aſtronomy and geometry, for making tables of logarithms, ephemerides, finding the time of eclipſes, &c. See ASTRONOMY, GEOMETRY, and LOGARITHMS.

CALCULUS, primarily denotes a little ſtone or pebble, anciently uſed in making computations, taking of ſuffrages, playing at tables, and the like. In after times, pieces of ivory, and counters ſtruck of ſilver, gold, and other matters, were uſed in lieu thereof, but ſtill retaining the ancient names. Computiſts were by the lawyers called *calculones*, when they were either ſlaves, or newly freed men; thoſe of a better condition were named *calculatores* or *numerarii*: ordinarily there was one of theſe in each family of diſtinction. The Roman judges anciently gave their opinions by calculi, which were white for abſolution, and black for condemnation. Hence *calculus albus*, in ancient writers, denotes a favourable vote, either in a perſon to be abſolved and acquitted of a charge, or elected to ſome dignity or poſt; as *calculus niger* did the contrary. This uſage is ſaid to have been borrowed from the Thracians, who marked their happy or proſperous days by *white*, and their unhappy by *black*, pebbles, put each night into an urn.

Beſides the diverſity of colour, there were ſome calculi alſo which had figures or characters engraven on them, as thoſe which were in uſe in taking the ſuffrages both in the ſenate and at aſſemblies of the people. Theſe calculi were made of thin wood, poliſhed and covered over with wax. Their form is ſtill ſeen in ſome medals of the Caſſian family; and the manner of caſting them into the urns, in the medals of the Licinian family. The letters marked upon theſe calculi were U. R. for *uti rogas*, and A. for *antiquo*; the firſt of which expreſſed an approbation of the law, the latter a rejection of it. Afterwards the judges who ſat in capital cauſes uſed calculi marked with the letter A. for *abſolvo*; C. for *condemno*; and N. L. for *non liquet*, ſignifying that a more full information was required.

Calculus is alſo uſed in ancient geometric writers for a kind of weight equal to two grains of cicer. Some make it equivalent to the ſiliqua, which is equal to three grains of barley. Two calculi made the ceratium.

CALCULUS, in *Mathematics*, is a certain method of performing inveſtigations and reſolutions, particularly in mechanical philoſophy. Thus there is the *Differential* calculus, the *Exponential*, the *Integral*, the *Literal*, and the *Antecedental*.

CALCULUS *Differentialis*, is a method of differencing quantities, or of finding an infinitely ſmall quantity, which being taken infinite times, ſhall be equal to a given quantity; or, it is the arithmetic of the infinitely ſmall differences of variable quantities.

The foundation of this calculus is an infinitely ſmall quantity, or an infiniteſimal, which is a portion of a quantity incomparable to that quantity, or that is leſs than any aſſignable one, and therefore accounted as nothing; the error accruing by omitting it being leſs than any aſſignable one. Hence two quantities, only differing by an infiniteſimal, are reputed equal. Thus, in aſtronomy, the diameter of the earth is an infiniteſimal, in reſpect of the diſtance of the fixed ſtars; and the ſame holds in abſtract quantities. The term, infiniteſimal, therefore, is merely reſpective, and involves a relation to another quantity; and does not denote any real ens or being. Now infiniteſimals are called *differentials*, or *differential quantities*, when they are conſidered as the differences of two quantities. Sir Iſaac Newton calls them *moments*; conſidering them as the momentary increments of quantities, v. g. of a line generated by the flux of a point, or of a ſurface by the flux of a line. The differential calculus, therefore, and the doctrine of fluxions, are the ſame thing under different names; the former given by M. Leibnitz, and the latter by Sir Iſaac Newton: each of whom lays claim to the diſcovery. There is, indeed a difference in the manner of expreſſing the quantities reſulting from the different views wherein the two authors conſider the infiniteſimals: the one as moments, the other as differences. Leibnitz, and moſt foreigners, expreſs the differentials of quantities by the ſame letters as variable ones, only prefixing the letter d: thus the differential of x is called dx; and that of y, dy: now dx is a poſitive quantity, if x continually increaſe; negative, if it decreaſe. The Engliſh, with Sir Iſaac

Newton, inſtead of $d\,x$ write $\dot{x}$ (with a dot over it), for $d\,y$, $\dot{y}$, &c. which foreigners object againſt, on account of that confuſion of points, which they imagine ariſes when differentials are again differenced; beſides, that the printers are more apt to overlook a point than a letter. Stable quantities being always expreſſed by the firſt letters of the alphabet $d\,a=o$, $d\,b=o$, $d\,c=o$; wherefore $d\,(x+y-a)=d\,x+d\,y$, and $d\,(x-y+a)=d\,x+d\,y$. So that the differencing of quantities is eaſily performed by the addition or ſubſtraction of their compounds.

To difference quantities that multiply each other; the rule is, firſt, multiply the differential of one factor into the other factor, the ſum of the two factors is the differential ſought: thus, the quantities being x, y, the differential will be $x\,d\,y+y\,d\,x$, i. e. $d\,(x\,y)=x\,d\,y+y\,d\,x$. Secondly, If there be three quantities mutually multiplying each other, the factum of the two muſt then be multiplied into the differential of the third; thus ſuppoſe $v\,x\,y$, let $v\,x=t$, then $v\,x\,y=t\,y$; conſequently $d\,(v\,x\,y)=t\,d\,y+y\,d\,t$: but $d\,t=v\,d\,x+x\,d\,v$. Theſe values, therefore, being ſubſtituted in the antecedent differential, $t\,d\,y+y\,d\,t$, the reſult is, $d\,(v\,x\,y)=v\,x\,d\,y+v\,y\,d\,x+x\,y\,d\,v$. Hence it is eaſy to apprehend how to proceed, where the quantities are more than three. If one variable quantity increaſe, while the other y decreaſes, it is evident $y\,d\,x-x\,d\,y$ will be the differential of $x\,y$.

To difference quantities that mutually divide each other; the rule is, firſt, multiply the differential of the diviſor into the dividend; and on the contrary, the differential of the dividend into the diviſor; ſubtract the laſt product from the firſt, and divide the remainder by the ſquare of the diviſor; the quotient is the differential of the quantities mutually dividing each other. See FLUXIONS.

CALCULUS *Exponentialis*, is a method of differencing exponential quantities, or of finding and ſumming up the differentials or moments of exponential quantities; or at leaſt bringing them to geometrical conſtructions.

By exponential quantity, is here underſtood a power, whoſe exponent is variable; v. g. x^x. a^x. x^y. where the exponent x does not denote the ſame in all the points of a curve, but in ſome ſtands for 2, in others for 3, in others for 5, &c.

To difference an exponential quantity; there is nothing required but to reduce the exponential quantities to logarithmic ones; which done, the differencing is managed as in logarithmic quantities.—Thus, ſuppoſe the differential of the exponential quantity x^y required, let

$$x^y=z$$

$$\text{Then will } y\,l\,x=l\,z$$

$$l\,x\,d\,y+\frac{y\,d\,x}{x}=\frac{d\,z}{z}.$$

$$z\,l\,x\,d\,y+\frac{z\,y\,d\,x}{x}=d\,z$$

That is, $x^y\,l\,x\,d\,y+x^{y-1}\,d\,x=d\,z$.

CALCULUS *Integralis*, or *Summatorius*, is a method of integrating, or ſumming up moments, or differential quantities; i. e. from a differential quantity given, to find the quantity from whoſe differencing the given differential reſults.

The integral calculus, therefore, is the inverſe of the differential one: whence the Engliſh, who uſually call the differential method *fluxions*, give this *calculus*, which aſcends from the fluxions, to the flowing or variable quantities: or as foreigners expreſs it, from the differences to the ſums, by the name of the *inverſe method of fluxions*.

Hence, the integration is known to be juſtly performed, if the quantity found, according to the rules of the differential calculus, being differenced, produce that propoſed to be ſummed.

Suppoſe $\int$ the ſign of the ſum, or integral quantity, then $\int y\,d\,x$ will denote the ſum, or integral of the differential $y\,d\,x$.

To integrate, or ſum up a differential quantity: it is demonſtrated, firſt, that $\int d\,x=x$: ſecondly, $\int(d\,x+d\,y)=x+y$: thirdly, $\int(x\,d\,y+y\,d\,x)-x\,y$: fourthly, $\int(m\,x^{m-1}\,d\,x)=x^m$: fifthly, $\int(n:m)\,x^{\frac{n-m}{m}}\,d\,x=x^{\frac{n}{m}}$: ſixthly, $\int(y\,d\,x-x\,d\,y):y^2=x:y$. Of theſe, the fourth and fifth caſes are the moſt frequent, wherein the differential quantity is integrated, by adding a variable unity to the exponent, and dividing the ſum by the new exponent multiplied into the differential of the root; v. g. the fourth caſe by $m-(1+1)d\,x$, i. e. by $m\,d\,x$.

If the differential quantity to be integrated doth not come under any of theſe formulas, it muſt either be reduced to an integral finite, or an infinite ſeries, each of whoſe terms may be ſummed.

It may be here obſerved, that, as in the analyſis of finites, any quantity may be raiſed to any degree of power; but *vice verſa*, the root cannot be extracted out of any number required: ſo in the analyſis of infinites, any variable or flowing quantity may be differenced; but *vice verſa*, any differential cannot be integrated. And as, in the analyſis of finites, we are not yet arrived at a method of extracting the roots of all equations, ſo neither has the integral calculus arrived at its perfection: and as in the former we are obliged to have recourſe to approximation, ſo in the latter we have recourſe to infinite ſeries, where we cannot attain to a perfect integration.

CALCULUS *Literalis*, or *Literal* CALCULUS, is the ſame with ſpecies arithmetic, or algebra, ſo called from its uſing the letters of the alphabet; in contradiſtinction to numeral arithmetic, which uſes figures. In the literal calculus given quantities are expreſſed by the firſt letters, $a\,b\,c\,d$; and quantities ſought by the laſt $z\,y\,x$, &c. Equal quantities are denoted by the ſame letters.

CALCULUS, *Antecedental*, a geometrical method of reaſoning invented by Mr Glenie, which, without any conſideration of motion or velocity, is applicable to all the purpoſes of fluxions. In this method, ſays Mr Glenie, "every expreſſion is truly and ſtrictly geometrical, is founded on principles frequently made uſe of by the ancient geometers, principles admitted into the very firſt elements of geometry, and repeatedly uſed by EUCLID himſelf. As it is a branch of general geometrical proportion, or univerſal compariſon, and is derived from an examination of the antecedents of ratios, having

Calculus. ing given conſequents and a given ſtandard of compariſon in various degrees of augmentation and diminution they undergo by compoſition and decompoſition, I have called it the antecedental calculus. As it is purely geometrical, and perfectly ſcientific, I have ſince it firſt occurred to me in 1779, always made uſe of it inſtead of the fluxionary and differential calculi, which are merely arithmetical. Its principles are totally unconnected with the ideas of motion and time, which, ſtrictly ſpeaking, are foreign to pure geometry and abſtract ſcience, though, in mixed mathematics and natural philoſophy, they are equally applicable to every inveſtigation, involving the conſideration of either with the two numerical methods juſt mentioned. And as many ſuch inveſtigations require compoſitions and decompoſitions of ratios, extending greatly beyond the triplicate and ſubtriplicate, this calculus in all of them furniſhes every expreſſion in a ſtrictly geometrical form. The ſtandards of compariſon in it may be any magnitudes whatever, and are of courſe indefinite and innumerable; and the conſequents of the ratios, compounded or decompounded, may be either equal or unequal, homogeneous or heterogeneous. In the fluxionary and differential methods, on the other hand, 1, or unit, is not only the ſtandard of compariſon, but alſo the conſequent of every ratio compounded or decompounded. See Phil. Tranſ. Edin. vol. iv.

Some mathematicians, however, are of opinion that the advantage to be derived from the employment of this calculus is not ſo great as the author ſeems to promiſe from it.

Calculus *Minervæ*, among the ancient lawyers, denoted the deciſion of a cauſe, wherein the judges were equally divided. The expreſſion is taken from the hiſtory of Oreſtes, repreſented by Æſchylus and Euripides; at whoſe trial, before the Areopagites, for the murder of his mother, the votes being equally divided for and againſt him, Minerva interpoſed, and gave the caſting vote or calculus in his behalf.

M. Cramer, profeſſor at Marpurg, has a diſcourſe expreſs, *De Calculo Minervæ;* wherein he maintains, that all the effect an entire equality of voices can have, is to leave the cauſe in *ſtatu quo*.

Calculus *Tiburtinus*, a ſort of a figured ſtone, formed in great plenty about the cataracts of the Anio, and other rivers in Italy; of a white colour, and in ſhape oblong, round, or echinated. They are a ſpecies of the *ſtiriæ lapideæ*, or *ſtalactites*, and generated like them; and ſo like ſugar plums, that it is a common jeſt at Rome to deceive the unexperienced by ſerving them up as deſſerts.

Calculus, in *Medicine*, the diſeaſe of the ſtone in the bladder, or kidneys. The term is Latin, and ſignifies a *little pebble*. The calculus in the bladder is called *lithiaſis;* and in the kidneys, *nephritis*. See Medicine and Surgery.

Human calculi are commonly formed of different ſtrata or incruſtations; ſometimes ſmooth and heavy like mineral ſtones; but often rough, ſpongy, light, and full of inequalities or protuberances: chemically analyzed, or diſtilled in an open fire, they nearly yield the ſame principles as urine itſelf, or at leaſt an empyreumatic volatile urinous matter, together with a great deal of air. They never have, nor can have, naturally, any foreign matter for a baſis: but they may by accident; an inſtance of which is related by Dr Percival *. A bougie had unfortunately ſlipped into the bladder, and upon it a ſtone of conſiderable ſize was formed in leſs than a year. This ſtone had ſo much the appearance of chalk, that the doctor was induced to try whether it could be converted into quicklime. His experiment ſucceeded, both with that and ſome other calculi; from which he conjectures, that hard waters which contain calcareous earth may contribute towards the formation of theſe calculi.

Calcutta. CALCUTTA, the capital of the province of Bengal, and of all the Britiſh poſſeſſions in the Eaſt Indies, is ſituated on the river Huguely, a branch of the Ganges, about 100 miles from the ſea, in N. Lat. 23. and Long. 88. 28. E. from Greenwich. It is but a modern city, built on the ſite of a village called *Govindpour*. The Engliſh firſt obtained the Mogul's permiſſion to ſettle in this place in the year 1690; and Mr Job Charnock, the company's agent, made choice of the ſpot on which the city ſtands, on account of a large ſhady grove which grew there; though in other reſpects it was the worſt he could have pitched upon; for three miles to the north coaſt, there is a ſalt water lake, which overflows in September, and when the flood retires in December, leaves behind ſuch a quantity of fiſh and other putreſcent matter, as renders the air very unhealthy. The cuſtom of the Gentoos throwing the dead bodies of their poor people into the river is alſo very diſguſtful, and undoubtedly contributes to render the place unhealthy, as well as the cauſe already mentioned.

Calcutta is now become a large and populous city, being ſuppoſed at preſent to contain 500,000 inhabitants. It is elegantly built, at leaſt the part inhabited by the Engliſh; but the reſt, and that the greateſt part, is built after the faſhion of the cities of India in general. The plan of all theſe is nearly the ſame; their ſtreets are exceedingly confined, narrow, and crooked, with a vaſt number of ponds, reſervoirs, and gardens interſperſed. A few of the ſtreets are paved with brick. The houſes are built, ſome with brick, others with mud, and a ſtill greater number with bamboos and mats; all which different kinds of fabrics ſtanding intermixed with one another, form a very uncouth appearance. The brick houſes are ſeldom above two ſtories high, but thoſe of mud and bamboos are only one, and are covered with thatch. The roofs of the brick houſes are flat and terraced. Theſe, however, are much fewer in number than the other two kinds; ſo that fires, which often happen, do not ſometimes meet with a brick houſe to obſtruct their progreſs in a whole ſtreet. Within theſe 20 or 25 years Calcutta has been greatly improved both in appearance and in the ſalubrity of its air: the ſtreets have been properly drained, and the ponds filled; thereby removing a vaſt ſurface of ſtagnant water, the exhalations of which were particularly hurtful. The citadel is named Fort William, and is ſuperior as a fortreſs to any in India; but is now on too extenſive a ſcale to anſwer the purpoſe for which it was intended, viz. the holding a poſt in caſe of extremity. It was begun on this extended plan by Lord Clive immediately after the battle of Plaſſey. The expence attending it was ſuppoſed to amount to two millions ſterling.

Calcutta is the emporium of Bengal, and the reſidence of the governor general of India. Its flouriſhing ſtate may in a great meaſure be ſuppoſed owing to the unlimited toleration of all religions allowed here; the Pagans being ſuffered to carry their idols in proceſſion, the Mahomedans not being diſcountenanced, and the Roman Catholics being allowed a church.—At about a mile's diſtance from the town is a plain where the natives annually undergo a very ſtrange kind of penance on the 9th of April; ſome for the ſins they have committed, others for thoſe they may commit, and others in conſequence of a vow made by their parents. This ceremony is performed in the following manner: Thirty bamboos, each about the height of 20 feet, are erected in the plain above-mentioned. On the top of theſe they contrive to fix a ſwivel, and another bamboo of thirty feet or more croſſes it, at each end of which hangs a rope. The people pull down one end of this rope, and the devotee placing himſelf under it, the bramin pinches up a large piece of ſkin under both the ſhoulderblades, ſometimes in the breaſts, and thruſts a ſtrong iron hook through each. Theſe hooks have lines of Indian graſs hanging to them, which the prieſt makes faſt to the rope at the end of the croſs bamboo, and at the ſame time puts a ſaſh round the body of the devotee, laying it looſely in the hollow of the hooks, leſt by the ſkin's giving way, he ſhould fall to the ground. When this is done, the people haul down the other end of the bamboo; by which means the devotee is immediately lifted up 30 feet or more from the ground, and they run round as faſt as their legs can carry them. Thus the devotee is thrown out the whole length of the rope, where, as he ſwings, he plays a thouſand antic tricks; being painted and dreſſed in a very particular manner, on purpoſe to make him look more ridiculous. Some of them continue ſwinging half an hour, others leſs. The devotees undergo a preparation of four days for this ceremony. On the firſt and third they abſtain from all kinds of food; but eat fruit on the other two. During this time of preparation they walk about the ſtreets in their fantaſtical dreſſes, dancing to the ſound of drums and horns; and ſome to expreſs the greater ardour of devotion, run a rod of iron quite through their tongues, and ſometimes through their cheeks alſo.

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* Eſſays, Vol. iii. p. 165.

Before the war of 1755, Calcutta was commonly garriſoned by 300 Europeans, who were frequently employed in conveying the company's veſſels from Patna, loaded with ſaltpetre, piece goods, opium, and raw ſilk. The trade of Bengal alone ſupplied rich cargoes for 50 or 60 ſhips annually, beſides what was carried on in ſmall veſſels to the adjacent countries. It was this flouriſhing ſtate of Calcutta that probably was one motive for the nabob Surajah Dowla to attack it in the year 1756. Having had the fort of Coſſimbuzar delivered up to him, he marched againſt Calcutta with all his forces, amounting to 70,000 horſe and foot, with 400 elephants, and inveſted the place on the 15th of June. Previous to any hoſtilities, however, he wrote a letter to Mr Drake the governor, offering to withdraw his troops, on condition that he would pay him his duty on the trade for 15 years paſt, defray the expence of his army, and deliver up the black merchants who were in the fort. This being refuſed, he attacked one of the redoubts at the entrance of the town; but was repulſed with great ſlaughter. On the 16th he attacked another advanced poſt, but was likewiſe repulſed with great loſs. Notwithſtanding this diſappointment, however, the attempt was renewed on the 18th, when the troops abandoned theſe poſts, and retreated into the fort; on which the nabob's troops entered the town, and plundered it for 24 hours. An order was then given for attacking the fort; for which purpoſe a ſmall breaſtwork was thrown up, and two twelve pounders mounted upon it; but without firing oftener than two or three times an hour. The governor then called a council of war, when the captain of the train informed them, that there was not ammunition in the fort to ſerve three days; in conſequence of which the principal ladies were ſent on board the ſhips lying before the fort. They were followed by the governor, who declared himſelf a Quaker, and left the place to be defended by Mr Holwell the ſecond in council. Beſides the governor, four of the council, eight gentlemen of the company's ſervice, four officers, and 100 ſoldiers, with 52 free merchants, captains of ſhips, and other gentlemen, eſcaped on board the ſhips, where were alſo 59 ladies, with 33 of their children The whole number left in the fort was about 250 effective men, with Mr Holwell, four captains, five lieutenants, ſix enſigns, and five ſerjeants; as alſo 14 ſea captains, and 29 gentlemen of the factory. Mr Holwell then having held a council of war, divided three cheſts of treaſure among the diſcontented ſoldiers, making them large promiſes alſo, if they behaved with courage and fidelity; after which he boldly ſtood on the defence of the place, notwithſtanding the immenſe force which oppoſed him. The attack was very vigorous; the enemy having got poſſeſſion of the houſes, galled the Engliſh from thence, and drove them from the baſtions; but they themſelves were ſeveral times diſlodged by the fire from the fort, which killed an incredible number, with the loſs of only five Engliſh ſoldiers the firſt day. The attack, however, was continued till the afternoon of the 20th; when many of the garriſon being killed and wounded, and their ammunition almoſt exhauſted, a flag of truce was hung out. Mr Holwell intended to have availed himſelf of this opportunity to make his eſcape on board the ſhips, but they had fallen ſeveral miles down from the fort, without leaving even a ſingle boat to facilitate the eſcape of thoſe who remained. In the mean time, however, the back-gate was betrayed by the Dutch guard, and the enemy, entering the fort, killed all they firſt met, and took the reſt priſoners.

The fort was taken before ſix in the evening; and, in an hour after, Mr Holwell had three audiences of the nabob, the laſt being in the durbar or council. In all of theſe the governor had the moſt poſitive aſſurances that no harm ſhould happen to any of the priſoners; but he was ſurpriſed and enraged at finding only 5000l. in the fort, inſtead of the immenſe treaſures he expected; and to this as well as perhaps to the reſentment of the jemmidaars or officers, of whom many were killed in the ſiege, we may impute the cataſtrophe that followed.

As ſoon as it was dark, the Engliſh priſoners, to the number of 146, were directed by the jemmidaars who guarded them, to collect themſelves into one body, and ſit down quietly under the arched veranda, or piazza, to the weſtward of the Black Hole priſon. Beſides the guard over them, another was placed at the ſouth end of this veranda, to prevent the eſcape of any of them. About 500 gunmen, with lighted matches, were drawn up on the parade; and ſoon after the factory was in flames to the right and left of the priſoners, who had various conjectures on this appearance. The fire advanced with rapidity on both ſides; and it was the prevailing opinion of the Engliſh, that they were to be ſuffocated between the two fires. On this they ſoon came to a reſolution of ruſhing on the guard, ſeizing their ſcimitars, and attacking the troops upon the parade, rather than be thus tamely roaſted to death: but Mr Holwell advanced, and found the Moors were only ſearching for a place to confine them in. At the time Mr Holwell might have made his eſcape, by the aſſiſtance of Mr Leech, the company's ſmith, who had eſcaped when the Moors entered the fort, and returned juſt as it was dark, to tell Mr Holwell he had provided a boat, and would enſure his eſcape, if he would follow him through a paſſage few were acquainted with, and by which he then entered. This might eaſily have been accompliſhed, as the guard took little notice of it; but Mr Holwell told Mr Leech, he was reſolved to ſhare the fate of the gentlemen and the garriſon; to which Mr Leech gallantly replied, that "then he was reſolved to ſhare Mr Holwell's fate, and would not leave him."

The guard on the parade advanced, and ordered them all to riſe and go into the barracks. Then, with their muſkets preſented, they ordered them to go into the Black Hole priſon: while others, with clubs and ſcimitars, preſſed upon them ſo ſtrong, that there was no reſiſting it; but, like one agitated wave impelling another, they were obliged to give way and enter; the reſt following like a torrent. Few among them, the ſoldiers excepted, had the leaſt idea of the dimenſions or nature of a place they had never ſeen; for if they had, they ſhould at all events have ruſhed upon the guard, and been cut to pieces by their own choice as the leſſer evil.

It was about eight o'clock when theſe 146 unhappy perſons, exhauſted by continual action and fatigue, were thus crammed together into a dungeon about eighteen feet ſquare, in a cloſe ſultry night in Bengal; ſhut up to the eaſt and ſouth, the only quarters from whence air could reach them, by dead walls, and by a wall and door to the north; open only to the weſt by two windows, ſtrongly barred with iron, from which they could receive ſcarce any circulation of freſh air.

They had been but few minutes confined before every one fell into a perſpiration ſo profuſe, that no idea can be formed of it. This brought on a raging thirſt, which increaſed in proportion as the body was drained of its moiſture. Various expedients were thought of to give more room and air. Every man was ſtripped, and every hat put in motion: they ſeveral times ſat down on their hams; but at each time ſeveral of the poor creatures fell, and were inſtantly ſuffocated or trode to death.

Before nine o'clock every man's thirſt grew intolerable, and reſpiration difficult. Efforts were again made to force the door; but ſtill in vain. Many inſults were uſed to the guards, to provoke them to fire in upon the priſoners, who grew outrageous, and many delirious. "Water, water," became the general cry. Some water was brought: but theſe ſupplies, like ſprinkling water on fire, only ſerved to raiſe and feed the flames. The confuſion became general and horrid from the cries and ravings for water; and ſome were trampled to death. This ſcene of miſery proved entertainment to the brutal wretches without, who ſupplied them with water, that they might have the ſatisfaction of ſeeing them fight for it, as they phraſed it; and held up lights to the bars, that they might loſe no part of the inhuman diverſion.

Before eleven o'clock, moſt of the gentlemen were dead, and one-third of the whole. Thirſt grew intolerable: but Mr Holwell kept his mouth moiſt by ſucking the perſpiration out of his ſhirt ſleeves, and catching the drops as they fell, like heavy rain, from his head and face. By half an hour after eleven, moſt of the living were in an outrageous delirium. They found that water heightened their uneaſineſs; and "Air, air," was the general cry. Every inſult that could be deviſed againſt the guard; all the opprobrious names that the viceroy and his officers could be loaded with, were repeated, to provoke the guard to fire upon them. Every man had eager hopes of meeting the firſt ſhot. Then a general prayer to heaven, to haſten the approach of the flames to the right and left of them, and put a period to their miſery. Some expired on others; while a ſteam aroſe as well from the living as the dead, which was very offenſive.

About two in the morning, they crowded ſo much to the windows, that many died ſtanding, unable to fall by the throng and equal preſſure round. When the day broke, the ſtench ariſing from the dead bodies was inſufferable. At that juncture, the ſoubah, who had received an account of the havock death had made among them, ſent one of his officers to enquire if the chief ſurvived. Mr Holwell was ſhown to him; and near ſix, an order came for their releaſe.

Thus they had remained in this infernal priſon from eight at night until ſix in the morning, when the poor remains of 146 ſouls, being only 23, came out alive; but moſt of them in a high putrid fever. The dead bodies were dragged out of the hole by the ſoldiers, and thrown promiſcuouſly into the ditch of an unfiniſhed ravelin, which was afterwards filled with earth.

The injuries which Calcutta ſuffered at this time, however, were ſoon repaired. The place was retaken by Admiral Watſon and Colonel Clive, early in 1737; Surajah Dowla was defeated, depoſed, and put to death; and Meer Jaffier, who ſucceeded him in the nabobſhip, engaged to pay an immenſe ſum for the indemnification of the inhabitants. Since that time, the immenſe acquiſition of territory by the Britiſh in this part of the world, with the conſtant ſtate of ſecurity enjoyed by this city, have given an opportunity of embelliſhing and improving it greatly beyond what it was before.—Among theſe improvements we may reckon that of Sir William Jones, who, on the 15th of January 1784, inſtituted a ſociety for inquiring into the hiſtory, civil and natural, the antiquities, arts, ſciences, and literature of Aſia; and thus the literature of Europe, and along with it, it is to be hoped, the arts of humanity, beneficence, and peace, have at length obtained a footing in the rich empire of Indoſtan, ſo long a prey to the rapine and violence of tyrants and uſurpers.

CALDARIUM, in the ancient baths, denoted a brazen veſſel or ciſtern, placed in the hypocauſtum, full of hot water, to be drawn thence into the *piſcina* or bath, to give it the neceſſary degree of heat. In this ſenſe the *caldarium* ſtood contradiſtinguiſhed from the *tepidarium* and *frigidarium*.

CALDARIUM, alſo denoted the ſtove, or ſudatory, being a cloſe vaulted room, wherein, by hot dry fumes, without water, people were brought to a profuſe ſweat. In which ſenſe, *caldarium* was the ſame with what was otherwiſe denominated *vaporarium*, *ſudatorium*, and *laconium*; in the Greek baths, *hypocauſtum*, ὑποκαυστον.

CALDERINUS, DOMITIUS, a learned critic, born at Calderia, near Verona. He read lectures upon polite literature at Rome with great reputation; and was the firſt who ventured to write upon the moſt difficult of the ancient poets. He died very young in 1477.

CALDERON DE LA BARCA, DOM PEDRO, a Spaniſh officer, who, after having ſignalized himſelf in the military profeſſion, quitted it for the eccleſiaſtical, and then commenced dramatic writer. His dramatic works make 9 vols. in 4to. and ſome Spaniſh authors have compared him to Shakeſpeare. He flouriſhed about the year 1640.

CALDERWOOD, DAVID, a famous divine of the church of Scotland, and a diſtinguiſhed writer in behalf of the Preſbyterians, was deſcended of a good family in that kingdom; and being early deſigned for the miniſtry, he applied with great diligence to the ſtudy of the Scriptures in their original tongues, the works of the fathers, the councils, and the beſt writers on church hiſtory. He was ſettled about the year 1604, at Crelling, near Jedburgh. King James I. of Great Britain, being deſirous of bringing the church of Scotland nearer to a conformity with that of England, laboured earneſtly to reſtore the epiſcopal authority, and enlarge the powers of the biſhops who were then in Scotland. This deſign was very warmly oppoſed by many of the miniſters, and particularly by Mr David Calderwood; who, when Mr James Law, biſhop of Orkney, came to viſit the preſbyteries of Merſe and Tiviotdale, declined his juriſdiction by a paper under his hand, dated May 5. 1608. But the king having its ſucceſs much at heart, ſent the earl of Dunbar, then high-treaſurer of Scotland, with Dr Abbot, afterward archbiſhop of Canterbury, and two other divines, into that kingdom, with inſtructions to employ every method to perſuade both the clergy and laity of his majeſty's ſincere deſire to promote the good of the church, and of his zeal for the Proteſtant religion. Mr Calderwood did not aſſiſt at the general aſſembly held at Glaſgow, June 8. 1610, in which Lord Dunbar preſided as commiſſioner; and it appears from his writings, that he looked upon every thing tranſacted in it as null and void. In May following, King James went to Scotland; and on the 17th of June held a parliament at Edinburgh. At that time the clergy met in one of the churches, to hear and adviſe with the biſhops, which kind of aſſembly, it ſeems, was contrived in order to reſemble the Engliſh convocation. Mr Calderwood was preſent at it, but declared publicly that he did not take any ſuch meetings to reſemble a convocation; and being oppoſed by Dr Whitford and Dr Hamilton, who were friends to the biſhops, he took his leave of them in theſe words: "It is abſurd to ſee men ſitting in ſilks and ſatins, and to cry poverty in the kirk, when purity is departing." The parliament proceeded in the meanwhile in the deſpatch of buſineſs; and Mr Calderwood, with ſeveral other miniſters, being informed that a bill was depending to empower the king, with the advice of the archbiſhops, biſhops, and ſuch a number of the miniſtry as his majeſty ſhould think proper, to conſider and conclude as to matters decent for the external policy of the church, not repugnant to the word of God; and that ſuch concluſions ſhould have the ſtrength and power of eccleſiaſtical laws: againſt this they proteſted, for four reaſons. 1. Becauſe their church was ſo perfect, that, inſtead of needing reformation, it might be a pattern to others. 2. General aſſemblies, as now eſtabliſhed by law, and which ought always to continue, might by this means be overthrown. 3. Becauſe it might be a means of creating ſchiſm, and diſturb the tranquillity of the church. 4. Becauſe they had received aſſurances, that no attempts ſhould be made to bring them to a conformity with the church of England. They deſired therefore, that, for theſe and other reaſons, all thoughts of paſſing ſuch a law might be laid aſide: but in caſe this be not done, they proteſt for themſelves and their brethren who ſhall adhere to them, that they can yield no obedience to this law, when it ſhall be enacted, becauſe it is deſtructive of the liberty of the church; and therefore ſhall ſubmit to ſuch penalties, and think themſelves obliged to undergo ſuch puniſhments, as may be inflicted on them for diſobeying that law. This proteſt was ſigned by Mr Archibald Simſon, on behalf of the members, who ſubſcribed another ſeparate roll, which he kept for his juſtification. This proteſt was preſented to the clerk regiſter, who refuſed to read it before the ſtates in parliament. However, though not read, it had its effect; for although the bill had the conſent of parliament, yet the king thought fit to cauſe it to be laid aſide, and not long after called a general aſſembly at St Andrew's. Soon after the parliament was diſſolved, and Mr Calderwood was ſummoned to appear before the high-commiſſion court at St Andrew's, on the 8th of July following, to anſwer for his mutinous and ſeditious behaviour. July 10th, the king came to that city in perſon; when Mr Calderwood, being called upon, and refuſing to comply with what the king in perſon required of him, was committed to priſon. Afterwards the privy council, according to the power exerciſed by them at that time, directed him to baniſh himſelf out of the king's dominions before Michaelmas next; and not to return without licenſe. Having applied to the king for a prorogation of his ſentence without ſucceſs, becauſe he would neither acknowledge his offence, nor promiſe conformity for the future, he retired to Holland, where, in 1623, he publiſhed his celebrated piece entitled *Altare Damaſcenum*. Mr Calderwood having in the year 1624 been afflicted with a long fit of ſickneſs, and nothing having been heard of him for ſome time, one Mr Patrick Scot, as Calderwood himſelf informs us, took it for granted that he was dead ; and thereupon wrote a recantation in his name, as if, before his deceaſe, he had changed his ſentiments. This impoſture being detected, Scott went over to Holland, and ſtaid three weeks at Amſterdam, where he made a diligent ſearch for the author of Altare Damaſcenum, with a deſign to have deſpatched him. But Calderwood had privately retired into his own country where he lived ſeveral years. Scott gave out that the king had furniſhed him with the matter for the pretended recantation, and that he only put it in order. During his retirement, Mr Calderwood collected all the memorials relating to the eccleſiaſtical affairs of Scotland, from the beginning of the reformation there down to the death of King James ; which collection is ſtill preſerved in the univerſity library of Glaſgow ; that which was publiſhed under the title of "The True Hiſtory of Scotland," is only an extract from it. In the advertiſement prefixed to the laſt edition of his Altare Damaſcenum mention is made of his being miniſter of Pencaitland near Edinburgh in 1638, but we find nothing ſaid there, or anywhere elſe, of his death.

CALDRON, a large kitchen utenſil, commonly made of copper ; having a moveable iron handle, whereby to hang it on the chimney hook. The word is formed from the French *chaudron*, or rather the Latin *caldarium*.

Boiling in Caldrons *(caldariis decoquere)*, is a capital puniſhment ſpoken of in the middle-age writers, decreed to divers ſort of criminals, but chiefly to debaſers of the coin. One of the torments inflicted on the ancient Chriſtian martyrs, was boiling in caldrons of water, oil, &c.

CALDWALL, Richard, a learned Engliſh phyſician, born in Staffordſhire about the year 1513. He ſtudied phyſic in Brazen-noſe College, Oxford ; and was examined, admitted into, and made cenſor of the College of Phyſicians at London, all in one day. Six weeks after he was choſen one of the elects ; and in the year 1570, he was made preſident of that college. Mr Wood tells us, that he wrote ſeveral pieces in his profeſſion ; but he does not tell us what they were, only that he tranſlated a book on the art of ſurgery, written by one Horatio More, a Florentine phyſician. We learn from Camden, that Caldwall founded a chirurgical lecture in the College of Phyſicians, and endowed it with a handſome ſalary. He died in 1585.

CALEA. See Botany *Index*.

CALEB, one of the deputies ſent by the Iſraelites to take a view of the land of Canaan. He made a good report of the country, and by this means revived the ſpirits of the dejected people ; on which account, he and Joſhua were the only perſons who, after their leaving Egypt, ſettled in the land of Canaan. Caleb had for his ſhare the mountains and the city of Hebron, from which he drove three kings. Othniel his nephew having taken the city of Debir, Caleb gave him his daughter Achſah in marriage ; and died, aged 114.

CALEDONIA, the ancient name of Scotland. From the teſtimonies of Tacitus, Dio, and Solinus, we find, that the ancient Caledonia comprehended all that country lying to the north of the rivers Forth and Clyde. In proportion as the Silures or Cimbri advanced towards the north, the Caledonians being circumſcribed within narrower limits, were forced to tranſmigrate into the iſlands which crowd the weſtern coaſts of Scotland. It is in this period, probably, we ought to place the firſt great migration of the Britiſh Gaël into Ireland ; that kingdom being much nearer to the promontory of Galloway and Cantire, than many of the Scotiſh iſles are to the continent of North Britain.

To the country which the Caledonians poſſeſſed, they gave the name of *Caël-doch* ; which is the only appellation the Scots, who ſpeak the Gaelic language, know for their own diviſion of Britain. *Caël-doch* is a compound, made up of *Gaël* or *Caël*, the firſt colony of the ancient Gauls who tranſmigrated into Britain, and *doch*, a diſtrict or diviſion of a country. The Romans, by tranſpoſing the letter *l* in *Cael*, and by ſoftening into a Latin termination the *ch* of *doch*, formed the well-known name of Caledonia.

When the tribes of North Britain were attacked by the Romans they entered into aſſociations, that, by uniting their ſtrength, they might be more able to repel the common enemy. The particular name of that tribe, which either its ſuperior power or military reputation placed at the head of the aſſociation, was the general name given by the Romans to all the confederates. Hence it is that the *Mæatæ*, who with other tribes inhabited the diſtricts of Scotland lying ſouthward of the frith, and the *Caledonians*, who inhabited the weſt and north-weſt parts, have engroſſed all the glory which belonged in common, though in an inferior degree, to all the other nations ſettled of old in North Britain. It was for the ſame reaſon that the name of *Mæatæ* was entirely forgotten by foreign writers after the third century, and that of the *Caledonians* themſelves but ſeldom mentioned after the fourth.

Britons, *Caledonians*, *Mæatæ*, *Barbarians*, are the names conſtantly given to the old inhabitants of North Britain, by Tacitus, Herodian, Dio, Spartian, Vopiſcus, and other ancient writers. The ſucceſſors of theſe Britons, Caledonians, Mœats, and Barbarians, are called Picts, Scots, and Attacots, by ſome Roman writers of the fourth century.

The origin of the appellations *Scoti* and *Picti*, introduced by later Roman authors, has occaſioned much controverſy among the antiquarians of theſe days. The diſpute ſeems now to be fully decided by ſome learned critics of the preſent century, whoſe knowledge of the Gaelic language aſſiſted their inveſtigation. See Scotland, Picts, and Highlanders.

Caledonia, the name of a ſettlement made by the Scots on the weſt ſide of the gulf of Darien, in 1698 ; out of which they were ſtarved at the requeſt of the Eaſt India Company ; for the Engliſh government prohibited the other colonies ſending them any proviſions ; ſo they were obliged to leave it in 1700.

New Caledonia, an iſland in the South ſea, lately diſcovered by Captain Cook, and next to New Holland and New Zealand, is the largeſt iſland that hath yet been diſcovered in that ſea. It extends from 19. 37. to 22. 30. S. Lat. and from 163. 37. to 167. 14. E. Long. Its length from north weſt to ſouth-eaſt is about 80 leagues : but its greateſt breadth does not exceed ten leagues. This iſland is diverſified with hills and valleys of various ſize and extent. From the hills iſſue abundance of rivulets, which contribute to fertilize the plains. Along its north-eaſt ſhore the land is flat; and being well watered, and cultivated by the inhabitants after their manner, appeared to great advantage to Captain Cook's people. Was it not, indeed, for thoſe fertile ſpots on the plains, the whole country might be called a *dreary waſte*: the mountains and higher parts of the land are in general incapable of cultivation. They conſiſt chiefly of rocks, many of which are full of mundic; the little ſoil that is upon them is ſcorched and burnt up by the ſun: it is, however, covered with coarſe graſs and other plants, and here and there covered with trees and ſhrubs. The country in general bears a great reſemblance to thoſe parts of New South Wales which lie under the ſame parallel of latitude. Several of its natural productions are the ſame, and the woods are without underwood as well as in that country. The whole coaſt ſeems to be ſurrounded by reefs and ſhoals, which render all acceſs to it extremely dangerous; but at the ſame time guard the coaſts againſt the attacks of the wind and ſea; rendering it eaſily navigable along the coaſt by canoes, and cauſing it abound with fiſh. Every part of the coaſt ſeems to be inhabited: the plantations in the plains are laid out with great judgment, and cultivated with much labour. They begin their cultivation by ſetting fire to the graſs, &c. with which the ground is covered, but have no notion of preſerving its vigour by manure; they, however, recruit it by letting it lie for ſome years untouched. On the beach was found a large irregular maſs of rock, not leſs than a cube of ten feet, conſiſting of a cloſe grained ſtone ſpeckled full of granite ſomewhat bigger than pins heads, from whence it ſeems probable that ſome valuable minerals may be found on this iſland. It differs from all the other iſlands yet diſcovered in the South ſea, by being entirely deſtitute of volcanic productions. Several plants of a new ſpecies were found here; and a few young bread-fruit trees, not then ſufficiently grown to bear fruit, ſeemed to have come up without culture; plantains and ſugar canes are here in ſmall quantity, and the cocoa-nut trees are ſmall and thinly planted. A new ſpecies of paſſion flower was likewiſe met with, which was never known to grow wild anywhere but in America. Several *Caputi* (MELALEUCA) trees were alſo found in flower. Muſquetos here are very numerous. A great variety of birds was ſeen of different claſſes, which were for the moſt part entirely new; particularly a beautiful ſpecies of parrot before unknown to zoologiſts. A new ſpecies of fiſh, of the genus called by Linnæus *tetraodon*, was caught here; and its liver, which was very large, preſented at ſupper. Several ſpecies of this genus being reckoned poiſonous, and the preſent ſpecies being remarkably ugly, Meſſ. Forſters hinted their ſuſpicions of its quality; but the temptation of a freſh meal, and the aſſurances of Captain Cook that he had formerly eaten this identical ſort of fiſh without harm, got the better of their ſcruples, and they ate of it. Its oilineſs, however, though it had no other bad taſte than what proceeded from this, prevented them from taking more than a morſel or two. In a few hours after they had retired to reſt, they were awaked by very alarming ſymptoms, being all ſeized with an extreme giddineſs; their hands and feet were numbed, ſo that they were ſcarcely able to crawl: and a violent languor and oppreſſion ſeized them. Emetics were adminiſtered with ſome ſucceſs, but ſudorifics gave the greateſt relief. Some dogs who had eaten the remainder of the liver were likewiſe taken ill; and a pig which had eaten the entrails died ſoon after, having ſwelled to an unuſual ſize. The effects of this poiſon on the gentlemen did not entirely go off in leſs than ſix weeks.— Abundance of turtle was ſeen here. The natives had not the leaſt notion of goats, hogs, dogs, or cats, and had not even a name for any of them.

The inhabitants are very ſtout, tall, and in general well proportioned; their features mild; their beards and hair black, and ſtrongly frizzled, ſo as to be ſomewhat woolly in ſome individuals: their colour is ſwarthy, or a dark cheſnut brown. A few were ſeen who meaſured ſix feet four inches. They are remarkably courteous, not at all addicted to pilfering and ſtealing: in which character of honeſty they are ſingular, all the other nations in the South ſea being remarkably thieviſh. Some wear their hair long, and tie it up to the crown of their heads; others ſuffer only a large lock to grow on each ſide, which they tie up in clubs; many others, as well as all the women, wear it cropt ſhort. They make uſe of a kind of comb made of ſticks of hard wood, from ſeven to nine or ten inches long, and about the thickneſs of knitting needles; a number of theſe, ſeldom exceeding 20, but generally fewer, are faſtened together at one end, parallel to and near one-tenth of an inch from each other: the ends, which are a little pointed, will ſpread out or open like the ſticks of a fan. Theſe combs they always wear in their hair on one ſide of their head. Some had a kind of concave cylindrical ſtiff black cap, which appeared to be a great ornament among them, and was ſuppoſed to be worn only by the chiefs and warriors. A large ſheet of ſtrong paper, whenever they got one in exchange, was commonly applied to this purpoſe. The men go naked; only tying a ſtring round their middle, and another round their neck. A little piece of a brown cloth made of the bark of a fig tree, ſometimes tucked up to the belt, and ſometimes pendulous, ſcarcely deſerves the name of a covering; nor indeed does it ſeem at all intended for that purpoſe. This piece of cloth is ſometimes of ſuch a length, that the extremity is faſtened to the ſtring round the neck; to this ſtring they likewiſe hang ſmall round beads of a pale green nephritic ſtone. Coarſe garments were ſeen among them made of a ſort of matting; but they ſeemed never to wear them, except when in their canoes and unemployed. The women ſeemed to be in a ſervile ſtate; they were the only perſons of the family who had any employment, and ſeveral of them brought bundles of ſticks and fuel on their backs; thoſe who had children carried them on their backs in a kind of ſatchel. The women alſo were ſeen to dig up the earth in order to plant it. They are in general of a dark cheſnut, and ſometimes mahogany brown; their ſtature middle-ſized, ſome being rather tall, and their whole form rather ſtout and ſomewhat clumſy. Their dreſs is the moſt diſfiguring that can be imagined, and gives them a thick ſquat ſhape; it is a ſhort petticoat or fringe, conſiſting of filaments or little cords, about eight inches long, which are faſtened to a very long ſtring, which they have tied ſeveral times round their waiſt. The filaments, or little ropes, therefore, lie above each other in ſeveral layers, forming a kind of thick thatch all round the body, but which does not near cover the thigh; theſe filaments were ſometimes dyed black; but frequently thoſe on the outſide only were of that colour, the reſt being of a dirty gray. There was not a ſingle inſtance, during the ſhips ſtay in this iſland, of the women permitting any indecent familiarity with an European: they took pleaſure in practiſing the arts of a jilting coquette, but never became abſolute wantons. The general ornaments of both ſexes are ear-rings of tortoiſe ſhells; necklaces, or amulets, made of both ſhells and ſtones; and bracelets made of large ſhells, which they wear above the elbows.

The houſes, or huts, in New Caledonia, are circular, ſomething like a bee-hive, and full as cloſe and warm; the entrance is by a ſmall door, or long ſquare hole, juſt big enough to admit a man bent double: the ſide walls are about four feet and a half high; but the roof is lofty, and peaked to a point at the top, above which is a poſt or ſtick of wood, which is generally ornamented either with carving or ſhells, or both. The framing is of ſmall ſpars, reeds, &c. and both ſides and roof are thick, and cloſe covered with thatch made of coarſe long graſs. In the inſide of the houſe are ſet up poſts, to which croſs ſpars are faſtened, and platforms made for the conveniency of laying any thing on. Some houſes have two floors, one above another; the floor is laid with dried graſs, and here and there mats are ſpread for the principal people to ſit or ſleep on. In theſe houſes there was no paſſage for the ſmoke but through the door: they were intolerably ſmoky, and ſo hot as to be inſupportable to thoſe unaccuſtomed to them: probably the ſmoke is intended to drive out the muſquetos which ſwarm here. They commonly erect two or three of theſe huts near each other under a cluſter of lofty fig trees, whoſe leaves are impervious to the rays of the ſun.

The canoes uſed here are very heavy clumſy veſſels; they are made of two trees hollowed out, having a raiſed gunnel about two inches high, and cloſed at each end with a bulk head of the ſame height; ſo that the whole is like a long ſquare trough about three feet ſhorter than the body of the canoe. Two canoes thus fitted are faſtened to each other about three feet aſunder, by means of croſs ſpars, which project about a foot over each ſide. Over theſe is laid a deck or heavy platform made of plank and ſmall round ſpars, on which they have a fire-hearth, and generally a fire burning; they are navigated by one or two latteen ſails, extended to a ſmall latteen yard, the end of which is fixed in a notch or hole in the deck.

Notwithſtanding the inoffenſive diſpoſition of the inhabitants of New Caledonia, they are well provided with offenſive weapons; as clubs, ſpears, darts, and ſlings for throwing ſtones. Their clubs are about two feet and a half long, and variouſly formed; ſome like a ſcythe, others like a pick-axe; ſome have a head like a hawk, and others have round heads; but all are neatly made; many of their darts and ſpears are no leſs neat and ornamented with carvings. The ſlings are as ſimple as poſſible; but they take ſome pains to form the ſtones that they uſe into a proper ſhape, which is ſomething like an egg, ſuppoſing both ends to be like the ſmall one. They drive the dart by the aſſiſtance of ſhort cords knobbed at one end and looped at the other, called by the ſeamen *beckets*. Theſe contain a quantity of red wool taken from the vampyre, or great Indian bat. Bows and arrows are wholly unknown among them.

Their language bears no affinity to that ſpoken in the other South ſea iſlands, the word *arrekee* and one or two more excepted. This is the more extraordinary, as different dialects of one language were ſpoken not only in the eaſterly iſlands, but at New Zealand.

A muſical inſtrument, a kind of whiſtle, was procured here. It was a little poliſhed piece of brown wood about two inches long, ſhaped like a kind of bell, though apparently ſolid, with a rope fixed at the ſmall end; two holes were made in it near the baſe, and another near the inſertion of the rope, all which communicated with each other; and by blowing in the uppermoſt, a ſhrill ſound like whiſtling was produced: no other inſtrument was ſeen among them that had the leaſt relation to muſic.

Many of the New Caledonians were ſeen with prodigiouſly thick legs and arms, which ſeemed to be affected with a kind of leproſy; the ſwelling was found to be extremely hard, but the ſkin was not alike harſh and ſcaly in all thoſe who were afflicted with the diſorder. The preternatural expanſion of the arm or leg did not appear to be a great inconvenience; and they ſeemed to intimate that they very rarely felt any pain in it; but in ſome the diſorder began to form blotches, which are marks of a great degree of virulence This diſeaſe is probably *elephantiaſis*.

Here they bury their dead in the ground. The grave of a chief who had been ſlain in battle here reſembled a large mole-hill, and was decorated with ſpears, darts, paddles, &c. all ſtuck upright in the ground round about it. Lieutenant Pickerſgill was ſhowed a chief whom they named *Tea-booma*, and ſtyled their *arrekee* or *king*; but nothing further is known of their government, and nothing at all of their religion.

CALEFACTION, the production of heat in a body from the action of fire, or that impulſe impreſſed by a hot body on others around it. This word is uſed in pharmacy, by way of diſtinction from *coction*, which implies boiling; whereas calefaction is only heating a thing.

CALENBERG, a caſtle of Germany, in the duchy of Brunſwick and principality of Calenberg. It is ſeated on the river Leine, and is 15 miles ſouth of Hanover. It is ſubject to the duke of Brunſwick Lunenberg, elector of Hanover, and king of Great Britain. E. Long. 9. 43. N. Lat. 52. 20.

Calenberg, a principality of Lower Saxony, and one of the three parts of the duchy of Brunſwick, is bounded on the north by the duchy of Verden, on the eaſt by the principality of Zell, on the ſouth by the principalities of Grubenhagen and Wolfenbuttle, and on the weſt by Weſtphalia. It belongs to the elector of Hanover.

CALENDAR, in *Aſtronomy* and *Chronology*. See Kalendar.

Calendar of priſoners, in *Law*, a liſt of all the priſoners names in the cuſtody of each reſpective ſheriff *.

CALENDARIUM Floræ, in *Botany*, a calendar containing

* See the article *Execution*.

containing an exact regiſter of the reſpective times in which the plants of any given province or climate germinate, expand, and ſhed their leaves and flowers, or ripen and diſperſe their ſeeds. For particulars on this curious ſubject, ſee the articles DEFOLIATIO, EFFLORESCENTIA, FRONDESCENTIA, FRUCTESCENTIA, and GERMINATIO.

CALENDER, a machine uſed in manufactories to preſs certain woolen and ſilken ſtuffs and linens, to make them ſmooth, even, and gloſſy, or to give them waves, or water them, as may be ſeen in mohairs and tabbies. This inſtrument is compoſed of two thick cylinders or rollers, of very hard and well poliſhed wood, round which the ſtuffs to be calendered are wound: theſe rollers are placed croſs-wiſe between two very thick boards, the lower ſerving as a fixed baſe, and the upper moveable by means of a thick ſcrew with a rope faſtened to a ſpindle, which makes its axis: the uppermoſt board is loaded with large ſtones weighing 20,000lb. or more. At Paris they have an extraordinary machine of this kind, called the *royal calender*, made by order of M. Colbert. The lower table or plank is made of a block of ſmooth marble, and the upper is lined with a plate of poliſhed copper. The alternate motion of the upper board ſometimes one way and ſometimes another, together with the prodigious weight laid upon it, gives the ſtuffs their gloſs and ſmoothneſs; or gives them the waves, by making the cylinders on which they are put roll with great force over the undermoſt board. When they would put a roller from under the calender, they only incline the undermoſt board of the machine. The dreſſing alone, with the many turns they make the ſtuffs and linens undergo in the calender, gives the waves, or waters them, as the workmen call it. It is a miſtake to think, as ſome have aſſerted, and Mr Chambers among others, that they uſe rollers with a ſhallow indenture or engraving cut in them.

CALENDER *of Monteith*, a diſtrict in the ſouth-weſt corner of Perthſhire in Scotland, from which a branch of the ancient family of Livingſtone had the title of earl. The chief ſeat of the family near Falkirk is alſo called *Calender*. Both eſtate and title were forfeited in conſequence of the poſſeſſor being engaged in the rebellion 1715.

CALENDERS, a ſort of Mahometan friars, ſo called from Santon Calenderi their founder. This Santon went bareheaded, without a ſhirt, and with the ſkin of a wild beaſt thrown over his ſhoulders. He wore a kind of apron before, the ſtrings of which were adorned with counterfeit precious ſtones. His diſciples are rather a ſect of epicures than a ſociety of religious. They honour a tavern as much as they do a moſque; and think they pay as acceptable worſhip to God by the free uſe of his creatures, as others do by the greateſt auſterities and acts of devotion. They are called, in Perſia and Arabia, *Abdals*, or *Abdallat*, i. e. perſons conſecrated to the honour and ſervice of God. Their garment is a ſingle coat, made up of a variety of pieces, and quilted like a rug. They preach in the market places, and live upon what their auditors beſtow on them. They are generally very vitious perſons: for which reaſon they are not admitted into any houſes.

CALENDS, in Roman antiquity. See KALENDS.

CALENDULA, the MARIGOLD. See Botany *Index*.

CALENTIUS, ELISIUS, a Neopolitan poet and proſe author. He was preceptor to Frederick the ſon of Ferdinand king of Naples, and the earlieſt writer on the illegality of putting criminals to death, except for murder. He died in 1503.

CALENTURE, a feveriſh diſorder incident to ſailors in hot countries; the principal ſymptom of which is their imagining the ſea to be green fields; hence, attempting to walk abroad in theſe imaginary places of delight, they are frequently loſt. Vomiting, bleeding, a ſpare diet, and the neutral ſalts, are recommended in this diſorder; a ſingle vomit commonly removing the delirium, and the cooling medicines completing the cure.

CALEPIN, AMBROSIUS, an Auguſtine monk of Calepio, whence he took his name, in the 16th century. He is author of a dictionary of eight languages, ſince augmented by Paſſerat and others.

CALES, in *Ancient Geography*, a municipal city of ſome note in Campania, at no great diſtance from Caſilinum. The epithet *Calenus* is by Horace and Juvenal applied to a generous wine which the territory produced.

CALETES, in *Ancient Geography*, a people of Gallia Celtica, on the confines of Belgica, ſituated between the ſea and the Sequana. Now called *le Paix de Caux*, in Normandy.

CALETURE, a fort on the iſland of Ceylon, at the mouth of a river of the ſame name. The Dutch became maſters of it in 1655; but were afterwards obliged to leave it. E. Long. 80. 51. N. Lat. 6. 38.

CALF, in *Zoology*, the young of the ox kind.

There are two ways of breeding calves that are intended to be reared. The one is to let the calf run about with its dam all the year round; which is the method in the cheap breeding countries, and is generally allowed to make the beſt cattle. The other is to take them from the dam after they have ſucked about a fortnight: they are then to be taught to drink flat milk, which is to be made but juſt warm for them, it being very dangerous to give it them too hot. The beſt time of weaning calves is from January to May: they ſhould have milk for 12 weeks after; and a fortnight before that is left off, water ſhould be mixed with the milk in larger and larger quantities. When the calf has been fed on milk for about a month, little wiſps of hay ſhould be placed all about him in cleft ſticks to induce him to eat. In the beginning of April they ſhould be turned out to graſs; only for a few days they ſhould be taken in for the night, and have milk and water given them: the ſame may alſo be given them in a pail ſometimes in the field, till they are ſo able to feed themſelves that they do not regard it. The graſs they are turned into muſt not be too rank, but ſhort and ſweet, that they may like it, and yet get it with ſome labour. Calves ſhould always be weaned at graſs; for if it be done with hay and water, they often grow big-bellied on it, and are apt to rot. When thoſe among the males are ſelected which are to be kept as bulls, the reſt ſhould be gelt for oxen: the ſooner the better. Between 10 and 20 days is a proper age. About London almoſt all the calves are fatted for the butcher. The reaſon of this is, that there is a good market for them; and the lands there are not ſo profitable to breed upon as in cheaper countries. The way to make calves fat and fine, is the keeping them very clean: giving them freſh litter every day: and the hanging a large chalk ſtone in ſome corner where they can eaſily get at it to lick it, but where it is out of the way of being fouled by their dung and urine. The coops are to be placed ſo as not to have too much ſun upon them, and ſo high above the ground that the urine may run off. They alſo bleed them once when they are a month old, and a ſecond time before they kill them; which is a great addition to the beauty and whiteneſs of their fleſh: the bleeding is by ſome repeated much oftener, but this is ſufficient. Calves are very apt to be looſe in their bowels; which waſtes and very much injures them. The remedy is to give them chalk ſcraped among milk, pouring it down with a horn. If this does not ſucceed, they give them bole armenic in large doſes, and uſe the cold bath every morning. If a cow will not let a ſtrange calf ſuck her, the common method is to rub both her noſe and the calf's with a little brandy; this generally reconciles them after a few ſmellings.

Golden Calf, an idol ſet up and worſhipped by the Iſraelites at the foot of Mount Sinai, in their paſſage through the wilderneſs to the land of Canaan. Our verſion makes Aaron faſhion this calf with a graving tool after he had caſt it in a mould: the Geneva tranſlation makes him engrave it firſt, and caſt it afterwards. Others, with more probability, render the whole verſe thus: "And Aaron received them (the golden ear-rings), and tied them up in a bag, and got them caſt into a molten calf:" which verſion is authoriſed by the different ſenſes of the word *tzur*, which ſignifies to tie up or bind, as well as to ſhape or form; and of the word *cherret*, which is uſed both for a graving tool and a bag. Some of the ancient fathers have been of opinion that this idol had only the face of a calf, and the ſhape of a man from the neck downwards, in imitation of the Egyptian Iſis. Others have thought it was only the head of an ox without a body. But the moſt general opinion is, that it was an entire calf in imitation of the Apis worſhipped by the Egyptians; among whom, no doubt, the Iſraelites had acquired their propenſity to idolatry. This calf Moſes is ſaid to have *burnt with fire*, reduced to powder, and ſtrewed upon the water which the people were to drink. How this could be accompliſhed hath been a queſtion. Moſt people have thought, that as gold is indeſtructible, it could only be burnt by the miraculous power of God; but M. Stahl conjectures that Moſes diſſolved it by means of liver of ſulphur *. The Rabbins tell us that the people were made to drink of this water in order to diſtinguiſh the idolaters from the reſt; for that as ſoon as they had drunk of it, the beards of the former turned red. The Cabbaliſts add, that the calf weighed 125 quintals; which they gather from the Hebrew word *maſſekah*, whoſe numerical letters make 125.

Calves Skins, in the leather manufacture, are prepared and dreſſed by the tanners, ſkinners, and curriers, who ſell them for the uſe of the ſhoemakers, ſaddlers, bookbinders, and other artificers, who employ them in their ſeveral manufactures.

Calf Skin dreſſed in ſumach, denotes the ſkin of this animal curried black on the hair ſide, and dyed of an orange colour on the fleſh ſide, by means of ſumach, chiefly uſed in the making of belts.

The Engliſh calf-ſkin is much valued abroad, and the commerce thereof very conſiderable in France and other countries; where divers attempts have been made to imitate it, but hitherto in vain. What is like to baffle all endeavours for imitating the Engliſh calf in France is, the ſmallneſs and weakneſs of the calves about Paris; which at 15 days old are not ſo big as the Engliſh ones when they come into the world.

Sea Calf. See Phoca, Mammalia *Index*.

CALI, a town of Popayan in South America, ſeated in a valley of the ſame name on the river Cauca. The governor of the province uſually reſides there. W. Long. 78. 5. N. Lat. 3. 15.

CALIBER, or Calliper, properly denotes the diameter of any body; thus we ſay, two columns of the ſame caliber, the caliber of the bore of a gun, the caliber of a bullet, &c.

Caliber Compaſſes, a ſort of compaſſes made with arched legs to take the diameter of round or ſwelling bodies. See Compasses.

Caliber compaſſes are chiefly uſed by gunners for taking the diameters of the ſeveral parts of a piece of ordnance, or of bombs, bullets, &c. Their legs are therefore circular; and move on an arch of braſs, whereon is marked the inches and half inches, to ſhow how far the points of the compaſſes are opened aſunder.

Some are alſo made for taking the diameter of the bore of a gun or mortar.

The gaugers alſo ſometimes uſe calibers, to embrace the two heads of any caſk, in order to find its length.

The caliber uſed by carpenters and joiners, is a piece of board notched triangular-wiſe in the middle for the taking of meaſure.

Caliber Rule, or *Gunners Callipers*, is an inſtrument wherein a right line is ſo divided as that the firſt part being equal to the diameter of an iron or leaden ball of one pound weight, the other parts are to the firſt as the diameters of balls of two, three, four, &c. pounds are to the diameter of a ball of one pound. The caliber is uſed by engineers, from the weight of the ball given, to determine its diameter or caliber, or *vice verſa*.

The gunners callipers conſiſt of two thin plates of braſs joined by a rivet, ſo as to move quite round each other: its length from the centre of the joint is between ſix inches and a foot, and its breadth from one to two inches; that of the moſt convenient ſize is about nine inches long. Many ſcales, tables, and proportions, &c. may be introduced on this inſtrument; but none are eſſential to it, except thoſe for taking the caliber of ſhot and cannon, and for meaſuring the magnitude of ſaliant and entering angles. The moſt complete callipers is exhibited Plate CXXXIII. the furniture and uſe of which we ſhall now briefly deſcribe. Let the four faces of this inſtrument be diſtinguiſhed by the letters A, B, C, D: A and D conſiſt of a circular head and leg; B and C conſiſt only of a leg.

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* See *Chemiſtry Index*.

On the circular head adjoining to the leg of the face A are diviſions denominated *ſhot diameters;* which ſhow the diſtance in inches and tenths of an inch of the points of the callipers when they are opened; ſo that if a ball not exceeding ten inches be introduced between them, the bevil edge E marks its diameter among theſe diviſions.

On the circular bevil part E of the face B is a ſcale of diviſions diſtinguiſhed by *lb. weight of iron ſhot.* When the diameter of any ſhot is taken between the points of the callipers, the inner edge of the leg A ſhows its weight in avoirdupois pounds, provided it be lb. ½, 1, 1½, 2, 3, 4, 5¼, 6, 8, 9, 12, 16, 18, 24, 26, 32, 36, or 42; the figures neareſt the bevil edge anſwering to the ſhort lines in the ſcale, and thoſe behind them to the longer ſtrokes. This ſcale is conſtructed on the following geometrical theorem, viz. that the weights of ſpheres are as the cubes of their diameters.

On the lower part of the circular head of the face A is a ſcale of diviſions marked *bores of guns;* for the uſe of which, the legs of the callipers are ſlipped acroſs each other, till the ſteel points touch the concave ſurface of the gun in its greateſt breadth; then the bevil edge F of the face B will cut a diviſion in the ſcale ſhowing the diameter of the bore in inches and tenths.

. Within the ſcales of *ſhot* and *bore* diameters on the circular part of A, are diviſions marked *pounders:* the inner figures ½, 1½, 3, 5¼, 8, 12, 18, 26, 36, correſpond to the longeſt lines; and the figures, 1, 2, 4, 6, 9, 16, 24, 32, 42, to the ſhort ſtrokes. When the bore of a gun is taken between the points of the callipers, the bevil edge F will either cut or be near one of theſe diviſions, and ſhow the weight of iron ſhot proper for that gun.

On the upper half of the circular head of the face A are three concentric ſcales of degrees; the outer ſcale conſiſting of 180 degrees numbered from right to left, 10, 20, &c. the middle numbered the contrary way, and the outer ſcale beginning at the middle, with 0, and numbered on each ſide to 90 degrees. Theſe ſcales ſerve to take the quantity of an angle, either entering or ſaliant. For an entering or internal angle, apply the legs of the callipers ſo that its outward edges coincide with the legs of the given angle, the degree cut by the bevil edge F in the outer ſcale ſhows the meaſure of the angle ſought: for a ſaliant or external angle, ſlip the legs of the callipers acroſs each other, ſo that their outward edges may coincide with the legs forming the angle, and the degree marked on the middle ſcale by the bevil edge E will ſhow the meaſure of the angle required. The inner ſcale will ſerve to determine the elevation of cannon and mortars, or of any oblique plane. Let one end of a thread be fixed into the notch on the plate B, and any weight tied to the other end: apply the ſtraight ſide of the plate A to the ſide of the body whoſe inclination is ſought; hold it in this poſition, and move the plate B, till the thread falls upon the line near the centre marked *perp.* Then will the bevil edge F cut the degrees on the inner ſcale, ſhowing the inclination of that body to the horizon.

On the face C near the point of the callipers is a little table ſhowing the proportion of troy and avoirdupois weights, by which one kind of weight may be eaſily reduced into another.

Near the extreme of the face D of the callipers are two tables ſhowing the proportion between the pounds weight of London and Paris, and alſo between the lengths of the foot meaſure of England and France.

Near the extreme on the face A is a table containing four rules of the circle and ſphere; and geometrical figures with numbers annexed to them: the firſt is a circle including the proportion in round numbers of the diameter to its circumference; the ſecond is a circle, inſcribed in a ſquare, and a ſquare within that circle, and another circle in the inner ſquare: the numbers 28, 22, above this figure exhibit the proportion of the outward ſquare to the area of the inſcribed circle; and the numbers 14, 11, below it, ſhow the proportion between the area of the inſcribed ſquare and the area of its inſcribed circle. The third is a cube inſcribed in a ſphere; and the number 89⅓ ſhows that a cube of iron, inſcribed in a ſphere of 12 inches in diameter, weighs 89⅓. The fourth is a ſphere in a cube, and the number 243 expreſſes the weight in pounds of a ſphere inſcribed in a cube whoſe ſide is 12 inches: the fifth repreſents a cylinder and cone of one foot diameter and height: the number in the cylinder ſhows, that an iron cylinder of that diameter and height weighs 364.5lb. and the number 121.5 in the cone expreſſes the weight of a cone, the diameter of whoſe baſe is 12 inches, and of the ſame height: the ſixth figure ſhows that an iron cube, whoſe ſide is 12 inches, weighs 464lb. and that a ſquare pyramid of iron, whoſe baſe is a ſquare foot and height 12 inches, weighs 154⅔lb. The numbers which have been hitherto fixed to the four laſt figures were not ſtrictly true; and therefore they have been corrected in the figure here referred to; and by theſe the figures on any inſtrument of this kind ſhould be corrected likewiſe.

On the leg B of the callipers, is a table ſhowing the weights of a cubic inch or foot of various bodies in pounds avoirdupois.

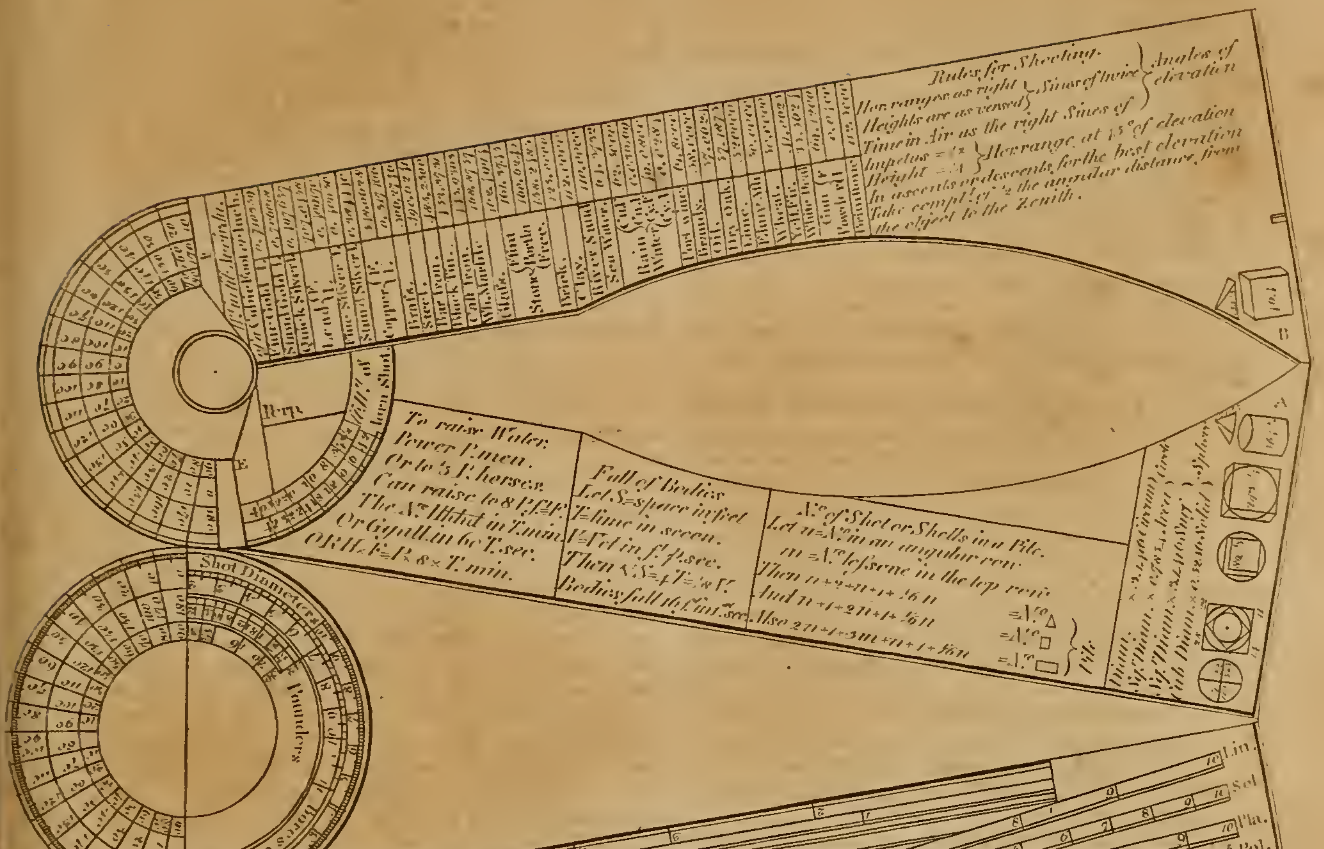
On the face D of the circular head of the callipers is a table contained between five concentric ſegments of rings: the inner one marked *Guns* ſhows the nature of the gun or the weight of ball it carries; the two next rings contain the quantity of powder uſed for proof and ſervice to braſs guns, and the two outermoſt rings ſhow the quantity for proof and ſervice in iron cannon.

On the face A is a table exhibiting the method of computing the *number of ſhot or ſhells* in a triangular, ſquare, or rectangular pile. Near this is placed a table containing the principal rules relative to the *fall of bodies,* expreſſed in an algebraic manner: nearer the centre we have another table of rules for raiſing water, calculated on the ſuppoſition, that one horſe is equal in this kind of labour to five men, and that one man will raiſe a hogſhead of water to eight feet of height in one minute, and work at that rate for ſome hours. N. B. Hogſheads are reckoned at 60 gallons.

Some of the leading principles in gunnery, relating to *ſhooting* in cannon and mortars, are expreſſed on the face B of the callipers. Beſides the articles already enumerated,

CALIBER Rule.

Plate CXXXIII.



A. Bell Prin. Mal. Sculptor fecit.

enumerated, the ſcales uſually marked on this ſector are laid down on this inſtrument: thus the line of inches is placed on the edge of the callipers, or on the ſtraight borders of the faces C, D: the logarithmic ſcales of numbers, ſines, verſed ſines, and tangents, are placed along theſe faces near the ſtraight edges: the line of lines is placed on the ſame faces in an angular poſition, and marked *Lin*. The lines of planes or ſuperficies are alſo exhibited on the faces C and D, tending towards the centre, and marked *Plan*. Finally, The lines of ſolids are laid on the ſame faces tending towards the centre, and diſtinguiſhed by *Sol*.

CALICOULAN, or QUILLON, a town of Aſia, in the Eaſt Indies, on the coaſt of Malabar, and in the peninſula on this ſide the Ganges, where the Dutch have a factory. E. Long. 75. 21. N. Lat. 9. 5.

CALICUT, a kingdom of India, on this ſide the Ganges, upon the coaſt of Malabar. It is about 63 miles long, and as much broad. It has many woods, rivers, and marſhes, and is very populous; but does not produce much corn, abundance of rice being imported from Canara. The land along the ſea coaſt is low and ſandy, and produces a number of cocoa trees. The higher grounds produce pepper and cardamoms of a very good quality. They have likewiſe timber for building, white and yellow ſanders, caſſia lignea, caſſia fiſtula, nux vomica, and cocculus indicus. The woods abound with parrots and monkeys, as well as different kinds of game. They have alſo plenty of fiſh, ſeveral ſorts of medicinal drugs, and their mountains produce iron. The *ſamorin*, or king, of Calicut, was once maſter of all the coaſt of Malabar; but at his death, he left it by will among four of his nephews. He who governs Calicut has a palace of ſtone, and there is ſome appearance of grandeur about his court. He carries on a conſiderable trade, which makes the people of Calicut richer than their neighbours. In former times they had ſeveral ſtrange cuſtoms, ſome of which are ſtill kept up; particularly the ſamorin's wife muſt be firſt enjoyed by the high-prieſt, who may have her three nights if he pleaſes. The nobles permit the other prieſts to take the ſame liberty, but the lower people cannot have that honour. A woman may marry a number of huſbands; each of whom has her ten days or more by turns, as they agree among themſelves; and provide her all things neceſſary during that time. When ſhe proves with child, ſhe names the father: who, after the child is weaned, takes care of its education. Theſe people have no pens, ink, or paper; but write with a bodkin on flags that grow by the ſides of the rivers. By this means the letters are in ſome ſenſe engraved; and ſo tough are the flags, that they will laſt for a great number of years. This was the firſt land diſcovered by the Portugueſe in 1498.

CALICUT, a town of Aſia, in the kingdom of that name on the coaſt of Malabar. It contains a great number of mean low houſes, each of which has a garden. The Engliſh had a factory here, but it is removed to Tellichery. E. Long. 76. 4. N. Lat. 11. 21.

CALIDÆ PLANTÆ (from *calor*, heat); plants that are natives of warm climates. Such are thoſe of the Eaſt Indies, South America, Egypt, and the Canary iſlands. Theſe plants, ſays Linnæus, will bear a degree of heat which is as 40 on a ſcale in which the freezing point is 0, and 100 the heat of boiling water. In the 10th degree of cold, they ceaſe to grow, loſe their leaves, become barren, are ſuffocated, and periſh.

CALIDUCT, in *Antiquity*, a kind of pipes or canal diſpoſed along the walls of houſes or apartments, uſed by the ancients for conveying heat to ſeveral remote parts of the houſe from one common furnace.

CALIFORNIA, the moſt northerly of all the Spaniſh dominions on the continent of America, is ſometimes diſtinguiſhed by the name of *New Albion*, and the *Iſlas Carrabiras*; but the moſt ancient appellation is *California*; a word probably owing to ſome accident, or to ſome words ſpoken by the Indians and miſunderſtood by the Spaniards. For a long time California was thought to be an iſland; but Father Caino, a German Jeſuit, diſcovered it to be a peninſula joining to the coaſt of New Mexico and the ſouthern parts of America. The peninſula extends from Cape St Sebaſtian, lying in north latitude 43. 30. to Cape St Lucar, which lies in north latitude 22. 32. It is divided from New Mexico by the gulf, or as ſome call it the *lake*, of California, or *Vermilion Sea*, on the eaſt; on the north, by that part of the continent of North America which is leaſt known; and on the weſt and ſouth, by the Pacific ocean or great South ſea. The coaſts, eſpecially towards the Vermilion ſea, are covered with inhabited iſlands, on ſome of which the Jeſuits have eſtabliſhed ſettlements, ſuch as St Clement, Paxaros, St Anne, Cedars (ſo called from the great number of theſe trees it produces), St Joſeph, and a multitude of others. But the iſlands beſt known are three lying off Cape St Lucar, towards the Mexican coaſt. Theſe are called *Les Tres Marias*, "the three Maries." They are ſmall, but have good wood and water, ſalt pits, and abundance of game; therefore the Engliſh and French pirates have ſometimes wintered there, when bound on cruiſes in the South ſeas.

As California lies altogether within the temperate zone, the natives are neither chilled with cold nor ſcorched with heat; and indeed the improvements in agriculture made by the Jeſuits afford ſtrong proofs of the excellency of the climate. In ſome places the air is extremely hot and dry; and the earth wild, rugged, and barren. In a country ſtretching about 800 miles in length, there muſt be conſiderable variations of ſoil and climate; and indeed we find, from good authority, that California produces ſome of the moſt beautiful lawns, as well as many of the moſt inhoſpitable deſerts, in the univerſe. Upon the whole, although California is rather rough and craggy, we are aſſured by the Jeſuit Vinegas, and other good writers, that with due culture it furniſhes every neceſſary and conveniency of life; and that, even where the atmoſphere is hotteſt, vapours riſing from the ſea, and diſperſed by pleaſant breezes, render it of a moderate temperature.

The peninſula of California is now ſtocked with all ſorts of domeſtic animals known in Spain and Mexico. Horſes, mules, aſſes, oxen, ſheep, hogs, goats, and all other quadrupeds imported, thrive and increaſe in this country. Among the native animals is a ſpecies of deer of the ſize of a young heifer, and greatly reſembling it in ſhape; the head is like that of a deer, and the horns thick and crooked like thoſe of a ram. The hoof of the animal is large, round, and cloven, the ſkin ſpotted, but the hair thinner, and the tail ſharper than thoſe of a deer. Its fleſh is greatly eſteemed. There is another animal peculiar to this country, larger and more bulky than a ſheep, but greatly reſembling it in figure, and like it, covered with a fine black or white wool. The fleſh of this animal is nouriſhing and delicious; and, happily for the natives, it is ſo abundant, that nothing more is required than the trouble of hunting, as theſe animals wander about in droves in the foreſts and on the mountains. Father Torquemado deſcribes a creature which he calls a *ſpecies of large bear*, ſomething like a buffalo, of the ſize of a ſteer, and nearly of the figure of a ſtag. Its hair is a quarter of a yard in length, its neck long and awkward, and on its forehead are horns branched like theſe of a ſtag. The tail is a yard in length, and half a yard in breadth; and the hoofs cloven like thoſe of an ox. With regard to birds, we have but an imperfect account; only, in general, Father Vinegas tells us that the coaſt is plentifully ſtored with peacocks, buſtards, geeſe, cranes, and moſt of the birds common in other parts of the world. The quantity of fiſh which reſort to theſe coaſts is incredible. Salmon, turbot, barbel, ſkate, mackerel, &c. are caught here with very little trouble; together with pearl oyſters, common oyſters, lobſters, and a variety of exquiſite ſhell fiſh. Plenty of turtle are alſo caught on the coaſts. On the South ſea coaſts are ſome ſhell fiſh peculiar to it, and perhaps the moſt beautiful in the world; their luſtre ſurpaſſing that of the fineſt pearl, and darting their rays through a tranſparent varniſh of an elegant vivid blue, like the lapis lazuli. The fame of California for pearls ſoon drew forth great numbers of adventurers, who ſearched every part of the gulf, and are ſtill employed in that work, notwithſtanding faſhion has greatly diminiſhed the value of this elegant natural production. Father Torquemado obſerves that the ſea of California affords very rich pearl fiſheries; and that the *hoſtias*, or beds of oyſters, may be ſeen in three or four fathom water, almoſt as plain as if they were on the ſurface.

The extremity of the peninſula towards Cape St Lucar is more level, temperate, and fertile, than the other parts, and conſequently more woody. In the more diſtant parts, even to the fartheſt miſſions on the eaſt coaſt, no large timber hath yet been diſcovered. A ſpecies of manna is found in this country, which, according to the accounts of the Jeſuits, has all the ſweetneſs of refined ſugar, without its whiteneſs. The natives firmly believe that this juice drops from heaven.

The Californians are well made, and very ſtrong. They are extremely puſillanimous, inconſtant, ſtupid, and even inſenſible, and ſeem extremely deſerving of the character given to the Indians in general, under the article AMERICA. Before the Europeans penetrated into California, the natives had no form of religion. The miſſionaries indeed tell us many tales concerning them, but they ſo evidently bear the marks of forgery, as not to be worth repeating. Each nation was then an aſſemblage of ſeveral cottages more or leſs numerous, that were all mutually confederated by alliances, but without any chief. They were ſtrangers even to filial obedience. No kind of dreſs was uſed by the men; but the women made uſe of ſome coverings, and were even fond of ornamenting themſelves with pearls and ſuch other trinkets as the country afforded. What moſt diſplayed their ingenuity was the conſtruction of their fiſhing nets, which are ſaid by the Jeſuits to have even exceeded in goodneſs thoſe made in Europe. They were made by the women, of a coarſe kind of flax procured from ſome plants which grow there. Their houſes were built of branches and leaves of trees; nay, many of them were only encloſures of earth and ſtone, raiſed half a yard high, without any covering; and even theſe were ſo ſmall, that they could not ſtretch themſelves at length in them. In winter, they dwelt under ground, in caves either natural or artificial.

In 1526, Ferdinand Cortez having reduced and ſettled Mexico, attempted the conqueſt of California; but was obliged to return, without even taking a ſurvey of the country, a report of his death having diſpoſed the Mexicans to a general inſurrection. Some other attempts were made by the officers of Cortez, but theſe were alſo unſucceſsful; and this valuable coaſt was long neglected by the Spaniards, who, to this day, have but one ſettlement upon it. In 1595, a galleon was ſent to make diſcoveries on the Californian ſhore; but the veſſel was unfortunately loſt. Seven years after, the count de Monteroy, then viceroy of New Spain, ſent Sebaſtian Biſcayno on the ſame deſign with two ſhips and a tender; but he made no diſcovery of importance. In 1684, the marquis de Laguna, alſo viceroy of New Spain, deſpatched two ſhips with a tender to make diſcoveries on the lake of California. He returned with an indifferent account, but was among the firſt who aſſerted that California was not an iſland; which was afterwards confirmed by Father Caino, as already related. In 1697, the Spaniards being diſcouraged by their loſſes and diſappointments, the Jeſuits ſolicited and obtained permiſſion to undertake the conqueſt of California. They arrived among the ſavages with curioſities that might amuſe them, corn for their food, and clothes for which they could not but perceive the neceſſity. The hatred theſe people bore the Spaniſh name, could not ſupport itſelf againſt theſe demonſtrations of benevolence. They teſtified their acknowledgments as much as their want of ſenſibility and their inconſtancy would permit them. Theſe faults were partly overcome by the religious inſtitutors, who purſued their project with a degree of warmth and reſolution peculiar to the ſociety. They made themſelves carpenters, maſons, weavers, and huſbandmen; and by theſe means ſucceeded in imparting knowledge, and in ſome meaſure a taſte for the uſeful arts, to this ſavage people, who have been all ſucceſſively formed into one body. In 1745, they compoſed 43 villages, ſeparated from each other by the barrenneſs of the ſoil and the want of water. The inhabitants of theſe ſmall villages ſubſiſt principally on corn and pulſe, which they cultivate; and on the fruits and domeſtic animals of Europe, the breeding of which laſt is an object of continual attention. The Indians have each their field, and the property of what they reap: but ſuch is their want of foreſight, that they would ſquander in a day what they had gathered, if the miſſionary did not take upon himſelf to diſtribute it to them as they ſtand in need of it. They manufacture ſome coarſe ſtuffs; and the neceſſaries they are in want of are purchaſed with pearls, and with wine nearly reſembling that of Madeira, which they ſell to the Mexicans and to the galleons, and which experience hath ſhown the neceſſity of prohibiting in California. A few laws, which are very ſimple, are ſufficient to regulate this riſing ſtate. In order to enforce them, the miſſionary chooſes the moſt intelligent perſon of the village; who is empowered to whip and impriſon; the only puniſhments of which they have any knowledge. In all California there are only two garriſons, each conſiſting of 30 men, and a ſoldier with every miſſionary. Theſe troops were choſen by the legiſlators, though they are paid by the government. Were the court of Madrid to puſh their intereſt with half the zeal of the Jeſuits, California might become one of the moſt valuable of their acquiſitions, on account of the pearls and other valuable articles of commerce which the country contains. At preſent the little Spaniſh town near Cape St Lucar is made uſe of for no other purpoſe than as a place of refreſhment for the Manilla ſhips, and the head reſidence of the miſſionaries.

CALIGA, in Roman antiquity, was the proper ſoldier's ſhoe, made in the ſandal faſhion, without upper leather to cover the ſuperior part of the foot, though otherwiſe reaching to the middle of the leg, and faſtened with thongs. The ſole of the caliga was of wood, like the ſabot of the French peaſants, and its bottom ſtuck full of nails; which clavi are ſuppoſed to have been very long in the ſhoes of the ſcouts and ſentinels; whence theſe were called by way of diſtinction, *caligæ ſpeculatoriæ*; as if by mounting the wearer to a higher pitch, they gave a greater advantage to the fight: though others will have the *caligæ ſpeculatoriæ* to have been made ſoft and woolly, to prevent their making a noiſe. From theſe *caligæ* it was that the emperor Caligula took his name, as having been born in the army, and afterwards bred up in the habit of a common ſoldier.

According to Du Cange, a ſort of *caligæ* was alſo worn by monks and biſhops, when they celebrated maſs pontifically.

CALIGATI, an appellation given by ſome ancient writers to the common ſoldiers in the Roman armies, by reaſon of the caliga which they wore. The caliga was the badge or ſymbol of a ſoldier; whence to take away the caliga and belt, imported a diſmiſſing or caſhiering.

CALIGO, or Caligatio, in *Medicine*, an opacity, or cloudineſs of the anterior ſurface of the cryſtaline lens of the eye, cauſing a dimneſs or ſuffuſion of ſight.

CALIGULA, the Roman emperor and tyrant, A. D. 37, began his reign with every promiſing appearance of becoming the real father of his people; but at the end of eight months he was ſeized with a fever, which it is thought, left a frenzy on his mind: for his diſpoſition totally changed, and he committed the moſt atrocious acts of impiety, cruelty, and folly; ſuch as proclaiming his horſe conſul, feeding it at his table, introducing it to the temple in the veſtments of the prieſts of Jupiter, &c. and cauſing ſacrifices to be offered to himſelf, his wife, and the horſe. After having murdered many of his ſubjects with his own hand, and cauſed others to be put to death without any juſt cauſe, he was aſſaſſinated by a tribune of the people as he came out of the amphitheatre, A. D. 41, in the 29th year of his age, and 4th of his reign.

CALIN, a compound metal, whereof the Chineſe make tea caniſters, and the like. The ingredients ſeem to be lead and tin.

CALIPH, or Khalif, the ſupreme eccleſiaſtical dignity among the Saracens; or as it is otherwiſe defined, a ſovereign dignity among the Mahometans, veſted with abſolute authority in all matters relating both to religion and policy. In the Arabic it ſignifies *ſucceſſor* or *vicar*; the caliphs bearing the ſame relation to Mahomet that the popes pretend they do to Jeſus Chriſt or St Peter. It is at this day one of the Grand Signior's titles, as ſucceſſor of Mahomet; and of the Sophi of Perſia, as ſucceſſor of Ali. One of the chief functions of the caliph, in quality of imam or chief prieſt of Muſſulmaniſm, was to begin the public prayers every Friday in the chief moſque, and to deliver the *khothbah* or ſermon. In after times, they had aſſiſtants for this latter office; but the former the caliphs always performed in perſon. The caliph was alſo obliged to lead the pilgrims to Mecca in perſon, and to march at the head of the armies of his empire. He granted inveſtiture to princes; and ſent ſwords, ſtandards, gowns, and the like, as preſents to princes of the Mahometan religion; who, though they had thrown off the yoke of the caliphate, nevertheleſs held of it as vaſſals. The caliphs uſually went to the moſque mounted on mules; and the ſultans Selgiucides, though maſters of Bagdad, held their ſtirrups, and led their mule by the bridle ſome diſtance on foot, till ſuch time as the caliphs gave them the ſign to mount on horſeback. At one of the windows of the caliph's palace, there always hung a piece of black velvet 20 cubits long, which reached to the ground, and was called the *caliph's ſleeve*; which the grandees of his court never failed to kiſs every day, with great reſpect. After the deſtruction of the caliphate by Hulaku, the Mahometan princes appointed a particular officer, in their reſpective dominions, who ſuſtains the ſacred authority of caliph. In Turkey, he goes under the denomination of *mufti*, and in Perſia under that of *ſadne*.

CALIPHATE, the office or dignity of caliph: See the preceding article. The ſucceſſions of caliphs continued from the death of Mahomet till the 655th year of the Hegira, when the city of Bagdad was taken by the Tartars. After this, however, there were perſons who claimed the caliphate, as pretending to be of the family of the Abaſſides, and to whom the ſultans of Egypt rendered great honours at Cairo, as the true ſucceſſors of Mahomet: but this honour was merely titular, and the rights allowed them only in matters relating to religion; and though they bore the ſovereign title of *caliphs*, they were nevertheleſs ſubjects and dependents of the ſultans. In the year of the Hegira 361, a kind of caliphate was erected by the Fatemites in Africa, and laſted till it was ſuppreſſed by Saladin. Hiſtorians alſo ſpeak of a third caliphate in Gemen or Arabia Felix, erected by ſome princes of the family of the Jobites. The emperors of Morocco aſſume the title of *grand cherifs*; and pretend to be the true caliphs, or ſucceſſors of Mahomet, though under another name.

CALIPPIC PERIOD, in *Chronology*, a ſeries of ſeventy-ſix ſeventy-ſix years, perpetually recurring; which elapſed, the middle of the new and full moons, as its inventor Calippus, an Athenian, imagined, return to the ſame day of the ſolar year. Meton, an hundred years before, had invented the period, or cycle, of nineteen years; aſſuming the quantity of the ſolar year $365d.\ 6h.\ 18'\ 56''\ 50^{3}\ 31^{4}\ 34^{5}$: and the lunar month, $29d.\ 12h.\ 45'\ 47''\ 26^{3}\ 48^{4}\ 30^{5}$: but Calippus, conſidering that the Metonic quantity of the ſolar year was not exact, multiplied Meton's period by 4, and thence aroſe a period of 76 years, called the *Calippic.* The Calippic period, therefore, contains 27,759 days: and ſince the lunar cycle contains 235 lunations, and the *Calippic period* is quadruple of this, it contains 940 lunations. This period began in the third year of the 112th Olympiad, or the 4384th of the Julian period. It is demonſtrated, however, that the Calippic period itſelf is not accurate; that it does not bring the new and full moons preciſely to their places; $8h.\ 5'\ 52''\ 60'''$, being the exceſs of 940 lunations, above 76 ſolar years; but brings them too late, by a whole day in 225 years.

CALISTA, in fabulous hiſtory, the daughter of Lycaon king of Arcadia, and one of the nymphs of Diana. Being beloved by Jupiter, that god aſſumed the form of the goddeſs of chaſtity, by which means he debauched her: but her diſgrace being revealed, as ſhe was bathing with her patroneſs, the incenſed deity turned her and the ſon with which ſhe was pregnant into bears; when Jupiter, in compaſſion to her ſufferings, took them up into the heavens, and made them the conſtellations Urſa Major and Urſa Minor.

CALIX. See Calyx.

CALIXTINS, a name given to thoſe, among the Lutherans, who follow the ſentiments of George Calixtus, a celebrated divine, and profeſſor at Helmſtadt in the duchy of Brunſwick, who died in 1656: he oppoſed the opinion of St Auguſtin, on predeſtination, grace, and free will, and endeavoured to form an union among the various members of the Romiſh, Lutheran, and reformed churches; or rather, to join them in the bonds of mutual forbearance and charity.

Calixtins alſo denote a ſect in Bohemia, derived from the Huſſites, about the middle of the 15th century, who aſſerted the uſe of the cup as eſſential to the euchariſt. And hence their name; which is formed from the Latin *calyx*, a cup.

The Calixtins are not ranked by Romaniſts in the liſt of heretics, ſince in the main they ſtill adhered to the doctrine of Rome. The reformation they aimed at terminated in the four following articles. 1. In reſtoring the cup to the laity. 2. In ſubjecting the criminal clerks to the puniſhment of the civil magiſtrate. 3. In ſtripping the clergy of their lands, lordſhips, and all temporal juriſdiction. 4. In granting liberty to all capable prieſts to preach the word of God.

CALKA, a kingdom of Tartary, in Aſia, to the eaſt of Siberia.

CALKING. See Caulking.

CALKINS, the prominent parts at the extremities of a horſe ſhoe, bent downwards, and forged to a ſort of point.

Calkins are apt to make horſes trip: they alſo occaſion bleymes, and ruin the back ſinews. If faſhioned in form of a hare's ear, and the horn of a horſe's heel be pared a little low, they do little damage; whereas, the great ſquare calkins quite ſpoil the foot.

Calkins are either ſingle or double, that is, at one end of the ſhoe, or at both: theſe laſt are deemed leſs hurtful, as the horſes can tread more even.

CALL, among hunters, a leſſon blown upon the horn, to comfort the hounds.

Call, an Engliſh name for the mineral called tungſten or wolfram by the Germans.

Call, among ſailors, a ſort of whiſtle or pipe, of ſilver or braſs, uſed by the boatſwain and his mates to ſummon the ſailors to their duty, and direct them in the different employments of the ſhip. As the call can be ſounded to various ſtrains, each of them is appropriated to ſome particular exerciſe; ſuch as hoiſting, heaving, lowering, veering away, belaying, letting go a tackle, &c. The act of winding this inſtrument is called piping, which is as attentively obſerved by ſailors as the beat of the drum to march, retreat, rally, charge, &c. is obeyed by ſoldiers.

Call, among fowlers, the noiſe or cry of a bird eſpecially to its young, or to its mate in coupling time. One method of catching partridges is by the natural call of a hen trained for the purpoſe, which drawing the cocks to her, they are entangled in a net. Different birds require different ſorts of calls; but they are moſt of them compoſed of a pipe or reed, with a little leathern bag or purſe, ſomewhat in form of a bellows; which, by the motion given thereto, yields a noiſe like that of the ſpecies of bird to be taken. The call for partridges is formed like a boat bored through, and fitted with a pipe or ſwan's quill, &c. to be blown with the mouth, to make the noiſe of the cock partridge, which is very different from the call of the hen. Calls for quails, &c. are made of a leathern purſe in ſhape like a pear, ſtuffed with horſe hair, and fitted at the end with the bone of a cat's, hare's, or coney's leg, formed like a flageolet. They are played, by ſqueezing the purſe in the palm of the hand, at the ſame time ſtriking on the flageolet part with the thumb to counterfeit the call of the hen quail.

Call of the Houſe. See Calling.

CALLA, Wake-robin, or *Ethiopian Arum.* See Botany *Index.*

Calla Suſung, a town of Aſia, in the iſland of Bouton in the Eaſt Indies. It is ſeated about a mile from the ſea, on the top of a ſmall hill ſurrounded with cocoa-nut trees. See Bouton.

CALLAO, a ſtrong town of South America, in Peru. It is the port of Lima, from which it is diſtant about five miles. The town is built on a low flat point of land on the ſea-ſhore. It is fortified; but the fortifications were much damaged by the laſt great earthquake, and have not ſince been repaired. The town is not above nine or ten feet above the level of high water mark; but the tide does not commonly riſe or fall above five feet. The ſtreets are drawn in a line; but are full of duſt, which is very troubleſome. In a ſquare near the ſea ſide are the governor's houſe, the viceroy's palace, the pariſh church, and a battery of three pieces of cannon. On the north ſide are the warehouſes for the merchandiſe brought from Chili, Mexico, and other parts of Peru. The other churches are built with reeds, and covered with timber or clay, but they look tolerably neat. There are five monaſteries and an hoſpital, though the number of families does not exceed 400. The trade of Callao is conſiderable. From Chili they bring cordage, leather, tallow, dried fiſh, and corn; from Chiloe, cedar planks, woollen manufactures, and carpets; from Peru, ſugars, wines, brandy, maſts, cordage, timber for ſhipping, cacao, tobacco, and melaſſes; from Mexico, pitch, tar, woods for dyeing, ſulphur, balſam of Peru, both white and brown, as well as commodities from China. At the port of Callao the watering is eaſy, but the wood is a mile or two diſtant. Earthquakes are very frequent in theſe parts, which have done vaſt miſchief to Lima and Callao. W. Long. 76. 15. S. Lat. 12. 29.

CALLE, in *Ancient Geography*, a town of Hither Spain, ſituated on an eminence which hangs over the river Durius; whoſe port was at the mouth of the river. Now *Porto, Oporto*, or *Port a Port.*

CALLEN, a town of Ireland, in the county of Kilkenny and province of Leinſter, about ten miles ſouth-weſt of Kilkenny. W. Long. 7. 22. N. Lat. 52. 25.

CALLICARPA. See JOHNSONIA.

CALLICO, in commerce, a ſort of cloth reſembling linens made of cotton. The name is taken from that of Calicut, a city on the coaſt of Malabar, being the firſt place at which the Portugueſe landed when they diſcovered the India trade. The Spaniards ſtill call it *callicu.*

Callicoes are of different kinds, plain, printed, painted, ſtained, dyed, chintz, muſlins, and the like, all included under the general denomination of *callicoes.* Some of them are painted with various flowers of different colours: others are not ſtained, but have a ſtripe of gold and ſilver quite through the piece, and at each end is fixed a tiſſue of gold, ſilver, and ſilk, intermixed with flowers. The printing of callicoes was firſt ſet on foot in London about the year 1676.

CALLICRATES, an ancient ſculptor, who engraved ſome of Homer's verſes on a grain of millet, made an ivory chariot that might be concealed under the wing of a fly, and an ant of ivory in which all the members were diſtinct: but Ælian juſtly blames him for exerting his genius and talents in things ſo uſeleſs, and at the ſame time ſo difficult. He flouriſhed about the year 472 before Chriſt.

CALLIGONUM. See BOTANY *Index.*

CALLIGRAPHUS anciently denoted a copyiſt, or ſcriviner, who tranſcribed fair, and at length, what the notaries had taken down in notes or minutes. The word is compounded of καλλος, *beauty*, and γραφω, I *write.* The minutes of acts, &c. were always taken in a kind of cypher, or ſhort hand; ſuch as the notes of Tyro in Gruter: by which means the notaries, as the Latins called them, or the σημειογραφοι and ταχυγραφοι, as the Greeks called them, were enabled to keep pace with a ſpeaker or perſon who dictated. Theſe notes, being underſtood by few, were copied over fair, and at length, by perſons who had a good hand, for ſale, &c. Theſe perſons were called *calligraphi*; a name frequently met with in the ancient writers.

CALLIGRAPHY, the art of fair writing. Callicrates is ſaid to have written an elegant diſtich on a ſeſamum ſeed. Junius ſpeaks of a perſon, as very extraordinary, who wrote the apoſtles creed, and beginning of St John's Goſpel, in the compaſs of a farthing. What would he have ſaid of our famous Peter Bale, who in 1575 wrote the Lord's prayer, creed, ten commandments, and two ſhort prayers in Latin, with his own name, motto, day of the month, year of the Lord, and reign of the queen, in the compaſs of a ſingle penny, enchaſed in a ring and border of gold, and covered with a cryſtal, all ſo accurately wrought as to be very legible?

CALLIMACHUS, a celebrated architect, painter, and ſculptor, born at Corinth, having ſeen by accident a veſſel about which the plant called *acanthus* had raiſed its leaves, conceived the idea of forming the Corinthian capital; hence the Corinthian order of architecture. The ancients aſſure us, that he worked in marble with wonderful delicacy. He flouriſhed about 540 B. C.

CALLIMACHUS, a celebrated Greek poet, native of Cyrene in Libya, flouriſhed under Ptolemy Philadelphus and Ptolemy Eurgetes kings of Egypt, about 280 years before Chriſt. He paſſed, according to Quintilian, for the prince of the Greek elegiac poets. His ſtyle is elegant, delicate, and nervous. He wrote a great number of ſmall poems, of which we have only ſome hymns and epigrams remaining. Catullus has cloſely imitated him, and tranſlated into Latin verſe his ſmall poem on the locks of Berenice. Callimachus was alſo a good grammarian and a learned critic. There is an edition of his remains, by Meſſ. le Fevre, quarto; and another in two volumes 8vo, with notes by Spanheim, Grævius, Bentley, &c.

CALLING the HOUSE, in the Britiſh parliament, is the calling over the members names, every one anſwering to his own, and going out of the houſe, in the order in which he is called: this they do in order to diſcover whether there be any perſon there not returned by the clerk of the crown, or if any member be abſent without the leave of the houſe.

CALLINICUS of Heliopolis, inventor of a compoſition to burn in the water, called the *Greek*, and ſince *Wild-fire.* See *Grecian* FIRE.

CALDINUS of Epheſus, a very ancient Greek poet, inventor of elegiac verſe; ſome ſpecimens of which are to be found in the collection of Stobeus. He flouriſhed about 776 years before Chriſt.

CALLIONYMUS, the DRAGONET. See ICHTHYOLOGY *Index.*

CALLIOPE, in the Pagan mythology, the Muſe who preſides over eloquence and heroic poetry. She was thus called from the ſweetneſs of her voice, and was reckoned the firſt of the nine ſiſters. Her diſtinguiſhing office was to record the worthy actions of the living; and accordingly ſhe is repreſented with tablets in her hand.

CALLIPÆDIA, the art of getting or breeding fine and beautiful children. We find divers rules and practices, relating to this art, in ancient and modern writers. Among the Magi, a ſort of medicine called *ermeſia* was adminiſtered to pregnant women, as a means of producing a beautiful iſſue. Of this kind were the kernels of pine nuts ground with honey, myrrh, ſaffron, palm wine and milk. The Jews are ſaid to have been ſo ſolicitous about the beauty of their children, that care was taken to have ſome very beautiful child placed at the door of the public baths, that the women at going out being ſtruck with his appearance, and retaining the idea, might all have children as fine as he. The Chineſe take ſtill greater care of their breeding women, to prevent uncouth objects of any kind from ſtriking their imagination. Muſicians are employed at night to entertain them with agreeable ſongs and odes, in which are ſet forth all the duties and comforts of a conjugal and domeſtic life; that the infant may receive good impreſſions even before it is born, and not only come forth agreeably formed in body, but well diſpoſed in mind. Callipædia, nevertheleſs, ſeems to have been firſt erected into a juſt art by Claude Quillet de Chinon, a French abbot, who, under the fictitious name of *Calvides Lætus*, has publiſhed a fine Latin poem in four books, under the title of *Callipædia, ſeu de pulchræ prolis habendæ ratione*; wherein are contained all the precepts of that new art. There is a tranſlation of it into Engliſh verſe by Mr Rowe.

CALLIPOLIS, in *Ancient Geography*, the name of ſeveral cities of antiquity, particularly one upon the Helleſpont, next the Propontis, and oppoſite to Lampſacus in Aſia. Now GALLIPOLI.

CALLIPPIC PERIOD. See CALIPPIC.

CALLIRRHOE, in *Ancient Geography*, ſurnamed *Enneacrunos*, from its nine ſprings or channels; a fountain not far from Athens, greatly adorned by Piſiſtratus, where there were ſeveral wells, but this the only running ſpring. Callirrhoe was alſo the name of a very fine ſpring of hot water beyond Jordan near the Dead Sea, into which it empties itſelf.

CALLISIA. See BOTANY *Index*.

CALLISTEA, in Grecian antiquity, a Leſbian feſtival, wherein the women preſented themſelves in Juno's temple, and the prize was aſſigned to the faireſt. There was another of theſe contentions at the feſtival of Ceres Eleuſinia among the Parrhaſians, and another among the Eleans, where the moſt beautiful man was preſented with a complete ſuit of armour, which he conſecrated to Minerva, to whoſe temple he walked in proceſſion, being accompanied by his friends who adorned him with ribbons, and crowned him with a garland of myrtle.

CALLISTHENES the philoſopher, diſciple and relation of Ariſtotle, by whoſe deſire he accompanied Alexander the Great in his expeditions; but proving too ſevere a cenſurer of that hero's conduct, he was by him put to the torture (on a ſuſpicion of a treaſonable conſpiracy), and died under it, 328 years before Chriſt.

CALLISTRATUS, an excellent Athenian orator, was baniſhed for having obtained too great an authority in the government. Demoſthenes was ſo ſtruck with the force of his eloquence, and the glory it procured him, that he abandoned Plato, and reſolved from thenceforward to apply himſelf to oratory.

CALLITRICHE, or STAR-GRASS, in *Botany*: A genus of the digynia order, belonging to the Monandria claſs of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. There is no calyx, but two petals, and the capſule is bilocular and tetraſpermous.

CALLOO, a fortreſs in the Netherlands, in the territory of Waes, on the river Scheldt, ſubject to the houſe of Auſtria. The Dutch were defeated here by the Spaniards in 1638. E. Long. 4. 10. N. Lat. 51. 15.

CALLOSUM CORPUS, in *Anatomy*, a whitiſh hard ſubſtance, joining the two hemiſpheres of the brain, and appearing in view when the two hemiſpheres are drawn back. See ANATOMY *Index*.

CALLOT, JAMES, a celebrated engraver, born at Nancy in 1593. In his youth he travelled to Rome to learn deſigning and engraving; and from thence went to Florence, where the grand duke took him into his ſervice. After the death of that prince, Callot returned to his native country; when he was very favourably received by Henry duke of Lorrain, who ſettled a conſiderable penſion upon him. His reputation being ſoon after ſpread all over Europe, the infanta of the Netherlands drew him to Bruſſels, where he engraved the ſiege of Breda. Louis XIII. made him deſign the ſiege of Rochelle, and that of the iſle of Rhé. The French king, having taken Nancy in 1631, made Callot the propoſal of repreſenting that new conqueſt, as he had already done the taking of Rochelle: but Callot begged to be excuſed; and ſome courtiers reſolving to oblige him to do it, he anſwered, that he would ſooner cut off his thumb than do any thing againſt the honour of his prince and country. This excuſe the king accepted; and ſaid, that the duke of Lorrain was happy in having ſuch faithful and affectionate ſubjects. Callot followed his buſineſs ſo cloſely, that, though he died at 43 years of age, he is ſaid to have left of his own execution about 1500 pieces. The following are a few of the principal. 1. The *murder of the innocents*, a ſmall oval plate, engraved at Florence. Callot engraved the ſame ſubject at Nancy, with ſome difference in the figures on the back ground. The former is the moſt rare; a fine impreſſion of it is very difficult to be found. 2. The *marriage of Cana in Galilee*, from Paola Veroneſe, a middling ſized plate, lengthwiſe. 3. The *paſſion of Chriſt*, on 12 very ſmall upright plates: firſt impreſſions very ſcarce. 4. *St John in the iſland of Patmos*, a ſmall plate, nearly ſquare. 5. The *temptation of St Anthony*, a middling ſized plate, lengthwiſe. He alſo engraved the ſame ſubject larger; which, though not the beſt, is notwithſtanding the ſcarceſt print. There is a conſiderable difference in the treatment of the ſubject in the two prints. 6. The *puniſhments*, wherein is ſeen the execution of ſeveral criminals. The marks of the beſt impreſſions of this plate are, a ſmall ſquare tower which appears above the houſes, towards the left, and a very ſmall image of the Virgin placed in an angle of the wall, near the middle of the print. 7. The *miſeries of war*, 18 ſmall plates, lengthwiſe. There is another ſet on the ſame ſubject, conſiſting of ſeven plates leſs than the former. 8. The *great fair of Florence*, ſo called becauſe it was engraved at Florence. As ſeveral parts of this plate were not equally bitten by the aquafortis, it is difficult to meet with a fine impreſſion. Callot, on his return to Nancy, re-engraved this plate without any alteration. The copy, however, is by no means equal to the original. The firſt is diſtinguiſhed from the ſecond by the words *in Firenza*, which appear below at the right-hand corner of the plate. The ſecond has theſe words in the ſame place, *Fe. Florientis, excudit Nancei.* There is alſo a large copy of this print, reverſed, publiſhed by Savery; but the difference is eaſily diſtinguiſhed between it and the true print. 9. The *little fair*, otherwiſe called the *players at bowls*; where alſo ſome peaſants are repreſented

presented dancing. This is one of the ſcarceſt of Callot's prints ; and it is very difficult to meet with a fine impreſſion of it, for the diſtances and other parts of the plate failed in the biting it with the aquafortis. 10. The *tilting, or the new ſtreet at Nancy*, a middling ſized plate, lengthwiſe. 11. The *Garden of Nancy*, where young men are playing with a balloon, the ſame. 12. *View of the Pont Neuf*, a ſmall plate, lengthwiſe. 13. *View of the Louvre*, the ſame. 14. *Four landſcapes*, ſmall plates, lengthwiſe.

CALLUS, or Callosity, in a general ſenſe, any cutaneous, corneous, or oſſeous hardneſs, whether natural or preternatural ; but moſt frequently it means the callus generated about the edges of a fracture, provided by nature to preſerve the fractured bones, or divided parts, in the ſituation in which they are replaced by the ſurgeon. A callus, in this laſt ſenſe, is a ſort of jelly, or liquid viſcous matter, that ſweats out from the ſmall arteries and bony fibres of the divided parts, and fills up the chinks or cavities between them. It firſt appears of a cartilaginous ſubſtance ; but at length becomes quite bony, and joins the fractured part ſo firmly together, that the limb will often make greater reſiſtance to any external violence, with this part than with thoſe which were never broken.

Callus is alſo a hard, denſe, inſenſible knob, riſing on the hands, feet, &c. by much friction and preſſure againſt hard bodies.

CALM, the ſtate of reſt which appears in the air and ſea when there is no wind ſtirring. A calm is more dreaded by a ſeafaring man than a ſtorm, if he has a ſtrong ſhip and ſea room enough ; for under the line exceſſive heat ſometimes produces ſuch dead calms, that ſhips are obliged to ſtay two or three months without being able to ſtir one way or other. Two oppoſite winds will ſometimes make a calm. This is frequently obſerved in the gulf of Mexico, at no great diſtance from the ſhore, where ſome guſt or land wind will ſo poiſe the general eaſterly wind, as to produce a perfect calm.

Calms are never ſo great on the ocean as on the Mediterranean, becauſe the flux and reflux of the former keep the water in a continual agitation, even where there is no wind ; whereas there being no tides in the latter, the calm is ſometimes ſo dead, that the face of the water is as clear as a looking glaſs ; but ſuch calms are almoſt conſtant preſages of an approaching ſtorm. On the coaſts about Smyrna, a long calm is reputed a prognoſtic of an earthquake.

It is not uncommon for the veſſels to be calmed, or becalmed, as the ſailors expreſs it, in the road of the conſtant Levantine winds, in places where they ride near the land. Thus between the two capes of Cartooche towards the main, and Cape Antonio in Cuba, the ſea is narrow, and there is often a calm produced by ſome guſt of a land wind, that poiſes the Levantine wind, and renders the whole perfectly ſtill for two or three days. In this caſe, the current that runs here is of uſe to the veſſels, if it ſets right ; when it ſets eaſterly, a ſhip will have a paſſage in three or four days to the Havannah ; but if otherwiſe, it is often a fortnight or three weeks ſail, the ſhip being embayed in the gulf of Mexico.

When the weather is perfectly calm, no wind at all ſtirring, the ſailors try which way the current ſets, by means of a boat which they ſend out, and which will ride at anchor, though there is no bottom to be found, as regularly and well as if faſtened by the ſtrongeſt anchor to the bottom. The method is this : they row the boat to a little diſtance from the ſhip, and then throw over their plummet, which is about forty pounds weight ; they let this ſink to about two hundred fathoms ; and then, though it never reaches the bottom, the boat will turn head againſt the current, and ride as firmly as can be.

Calm Latitudes, in ſea language, are ſituated in the Atlantic ocean, between the tropic of Cancer and the latitude of 29° N. or they denote the ſpace that lies between the trade and variable winds, becauſe it is frequently ſubject to calms of long duration.

CALMAR, a ſtrong ſea port of Sweden, in the province of Smaland, divided into two towns, the old and the new ; but of the former there remains only the church and a few houſes. The new town is built a little way from the other, and has large handſome houſes. E. Long. 16. 15. N. Lat, 56. 48.

CALMET, Augustine, one of the moſt learned and laborious writers of the 18th century, was born at Meſnil le Horgne, a village in the dioceſe of Toul in France, in the year 1672, and took the habit of the Benedictines in 1688. Among the many works he publiſhed are, 1. A literal expoſition in French, of all the books in the Old Teſtament, in nine volumes folio. 2. An hiſtorical, critical, chronological, geographical, and literal dictionary of the Bible, in four vols. folio, enriched with a great number of figures of Jewiſh antiquities. 3. A civil and eccleſiaſtical hiſtory of Lorrain, three vols. folio. 4. A hiſtory of the Old and New Teſtament, and of the Jews, in two volumes folio, and ſeven vols. duodecimo. 5. An univerſal ſacred and profane hiſtory, in ſeveral volumes quarto. He died in 1757.

CALMUCKS. See Kalmucks.

CALNE, a town of Wiltſhire in England, ſeated on a river of the ſame name. It has a handſome church, and ſends two members to parliament. W. Long. 1. 59. N. Lat. 51. 30.

CALNEH, in *Ancient Geography*, a city in the land of Shinar, built by Nimrod, and the laſt city mentioned (Gen. x. 10.) as belonging to his kingdom. It is believed to be the ſame with Calno, mentioned in Iſaiah (x. 9.) and with Canneh in Ezekiel (xxvii 23.) with ſtill greater variation. It is obſerved, that it muſt have been ſituated in Meſopotamia, ſince theſe prophets join it with Haran, Eden Aſſyrian, and Chilmad, which carried on a trade with Tyre. It is ſaid by the Chaldee interpreters, as alſo by Euſebius and Jerome, to be the ſame with Cteſiphon, ſtanding upon the Tigris, about three miles diſtant from Seleucia, and that for ſome time it was the capital city of the Parthians.

CALOGERI, in church hiſtory, monks of the Greek church, divided into three degrees : the novices, called *archari* ; the ordinary profeſſed, called *microchemi* ; and the more perfect, called *megalochemi* : they are likewiſe divided into cænobites, anchorets, and recluſes. The cænobites are employed in reciting their offices from midnight to ſunſet, they are obliged to make three genuflexions at the door of the choir, and, returning, to bow to the right and to the left, to their brethren. The anchorets retire from the converſation of the world, and live in hermitages in the neighbourhood of the monaſteries; they cultivate a little ſpot of ground, and never go out but on Sundays and holidays to perform their devotions at the next monaſtery. As for the recluſes, they ſhut themſelves up in grottos and caverns on the tops of mountains, which they never go out off, abandoning themſelves entirely to Providence: they live on the alms ſent them by the neighbouring monaſteries.

CALOMEL, or dulcified ſublimate of mercury, is a combination of mercury with the muriatic acid, in the preſent nomenclature called a *ſub-muriate of mercury*. See Pharmacy and Chemistry *Index*.

CALOPHYLLUM. See Botany *Index*.

CALOTTE, a cap or coif of hair, ſatin, or other ſtuff; an eccleſiaſtical ornament in moſt Popiſh countries. See Cap.

Calotte, in *Architecture*, a round cavity or depreſſure, in form of a cap or cup, lathed and plaſtered, uſed to diminiſh the riſe or elevation of a moderate chapel, cabinet, alcove, &c. which without ſuch an expedient would be too high for other pieces of the apartment.

CALPE, a mountain of Andaluſia in Spain; at the foot of which, towards the ſea, ſtands the town of Gibraltar. It is half a league in height towards the land, and ſo ſteep that there is no approaching it on that ſide.

CALPURNIUS, Titus, a Latin Sicilian poet, lived under the emperor Carus and his ſon. We have ſeven of his eclogues remaining.

CALQUING, or Calking, a term uſed in painting, &c. where the back ſide of any thing is covered over with a black or red colour, and the ſtrokes, or lines traced through on a waxed plate, wall, or other matter, by paſſing lightly over each ſtroke of the deſign with a point, which leaves an impreſſion of the colour on the plate or wall.

CALTHA. See Botany *Index*. There is only one ſpecies known, which grows naturally in moiſt boggy lands in many parts of England and Scotland. The flowers gathered before they expand, and preſerved in ſalted vinegar, are a good ſubſtitute for capers. The juice of the petals, boiled with a little alum, ſtains paper yellow. The remarkable yellowneſs of the butter in ſpring is ſuppoſed to be cauſed by this plant: but cows will not eat it, unleſs compelled by extreme hunger; and then, Boerhaave ſays, it occaſions ſuch an inflammation, that they generally die. Upon May-day, the country people ſtrew the flowers upon the pavment before their doors. Goats and ſheep eat this plant; horſes, cows, and ſwine, refuſe it.

CALTROP. See Tribulus, Botany *Index*.

Caltrop, in military affairs, an inſtrument with four iron points, diſpoſed in a triangular form, ſo that three of them are always on the ground, and the fourth in the air. They are ſcattered over the ground where the enemy's cavalry is to paſs, in order to embarraſs them.

CALVARIA, in *Anatomy*, the hairy ſcalp or upper part of the head, which, either by diſeaſe or old age, grows bald firſt.

CALVART, Denis, a celebrated painter, was born at Antwerp in 1552; and had for his maſters Proſpero Fontana and Lorenzo Sabbatini. He opened a ſchool at Bologna, which became celebrated; and from which proceeded Guido, Albani, and other great maſters. Calvart was well ſkilled in architecture, perſpective, and anatomy, which he conſidered as neceſſary to a painter, and taught them to his pupils. His principal works are at Bologna, Rome, and Reggio. He died at Bologna in 1619.

CALVARY, a term uſed in Catholic countries for a kind of chapel of devotion raiſed on a hillock near a city, in memory of the place where Jeſus Chriſt was crucified near the city of Jeruſalem. The word comes from the Latin *calvarium*; and that from *calvus*, bald, in regard the top of that hillock was bare and deſtitute of verdure; which is alſo ſignified by the Hebrew word *golgotha*. Such is the Calvary of St Valerian near Paris; which is accompanied with ſeveral little chapels, in each of which is repreſented in ſculpture one of the myſteries of the Paſſion.

Calvary, in *Heraldry*, a croſs ſo called, becauſe it reſembles the croſs on which our Saviour ſuffered. It is always ſet upon ſteps.

CALVERT, George, afterwards Lord Baltimore, was born at Kipling in Yorkſhire about the year 1582, and educated at Oxford, where he took the degree of bachelor of arts, and afterwards travelled. At his return, he was made ſecretary to Sir Robert Cecil: he was afterwards knighted, and in 1618 appointed one of the principal ſecretaries of ſtate. But after he had enjoyed that poſt about five years, he willingly reſigned it; freely owning to his majeſty that he was become a Roman Catholic, ſo that he muſt either be wanting to his truſt, or violate his conſcience in diſcharging his office. This ingenuous confeſſion ſo affected King James, that he continued him privy counſellor all his reign, and the ſame year created him baron of Baltimore in the kingdom of Ireland. He had before obtained a patent for him and his heirs, for the province of Avelon in Newfoundland: but that being expoſed to the inſults of the French, he abandoned it, and afterwards obtained the grant of a country on the north part of Virginia from Charles I. who called it *Maryland*, in honour of his queen: but he died in April 1632 (aged 50), before the patent was made out. It was, however, filled up to his ſon Cecil Calvert Lord Baltimore; and bears date June 20. 1632. It is held from the crown as part of the manor of Windſor, on one very ſingular condition, viz. to preſent two Indian arrows yearly, on Eaſter Tueſday, at the caſtle, where they are kept and ſhown to viſitors.—His lordſhip wrote, 1. A Latin poem on the death of Sir Henry Upton. 2. Speeches in parliament. 3. Various letters of ſtate. 4. The anſwer of Tom Tell-truth. 5 The Practice of Princes. And, 6. The Lamentation of the Kirk.

CALVI, a town of the province of Lavoro, in the kingdom of Naples, ſituated near the ſea, about fifteen miles north of the city of Naples. E. Long. 14. 45. N. Lat. 41. 15.

Calvi is alſo the name of a ſea port in the iſland of Corſica, ſituated on a bay, on the weſt ſide of the iſland, about 40 miles ſouth-weſt of Baſtia. E. Long. 9. 5. N. Lat. 42. 16.

CALVIN, John, the celebrated reformer of the Chriſtian church from Romiſh ſuperſtitions and doctrinal errors, and founder of the ſect ſince called *Calviniſts*, was born in 1509. He was the ſon of a cooper of Noyon in Picardy; and his real name was *Chauvin*, which he choſe to latinize into *Calvinus*, ſtyling himſelf in the title page to his firſt work (a Commentary on *Seneca de clementia*), "Lucius Calvinus, Civis Romanus;" an early proof of his pride, at about 24 years of age. In 1529, he was rector of Pont l'Eveque; and in 1534 he threw up this benefice, ſeparating himſelf entirely from the Romiſh church. The perſecution againſt the Proteſtants in France (with whom he was now aſſociated) obliged him to retire to Baſle in Switzerland: here he publiſhed his famous Inſtitutes of the Chriſtian religion in 1535. The following year he was choſen profeſſor of divinity, and one of the miniſters of the church at Geneva. The next year, viz. 1537, he made all the people ſolemnly ſwear to a body of doctrines; but finding that religion had not yet had any great influence on the morals of the people, he, aſſiſted by other miniſters, declared, that ſince all their admonitions and warnings had proved unſucceſsful, they could not celebrate the holy ſacrament as long as theſe diſorders reigned; he alſo declared, that he could not ſubmit to ſome regulations made by the ſynod of Berne. Upon which the ſyndics having ſummoned the people, it was ordered that Calvin and two other miniſters ſhould leave the city within two days. Upon this Calvin retired to Straſburg, where he eſtabliſhed a French church, of which he was the firſt miniſter, and was alſo choſen profeſſor of divinity there. Two years after he was choſen to aſſiſt at the diet appointed by the emperor to meet at Worms and at Ratiſbon in order to appeaſe the troubles occaſioned by the difference of religion. He went with Beucer, and entered into a conference with Melancthon. The people of Geneva now entreated him to return; to which he conſented, and arrived at Geneva, September 13. 1541. He began with eſtabliſhing a form of eccleſiaſtical diſcipline, and a conſiſtorial juriſdiction, with the power of inflicting all kinds of canonical puniſhments. This was greatly diſliked by many perſons, who imagined that the papal tyranny would ſoon be revived. Calvin, however, aſſerted on all occaſions the rights of his conſiſtory with inflexible ſtrictneſs; and he cauſed Michael Servetus to be burnt at the ſtake for writing againſt the doctrine of the Trinity. But though the rigour of his proceedings ſometimes occaſioned great tumults in the city, yet nothing could ſhake his ſteadineſs and inflexibilty. Amongſt all the diſturbances of the commonwealth, he took care of the foreign churches in England, France, Germany, and in Poland; and did more by his pen than his preſence, ſending his advice and inſtructions by letter, and writing a greater number of books. This great reformer died on the 27th of May 1564, aged 55. His works were printed together at Amſterdam in 1671, in nine volumes folio; the principal of which are his Inſtitutions, in Latin, the beſt edition of which is that of Robert Stephens in 1553, in folio; and his Commentaries on the Holy Scriptures.—Calvin is univerſally allowed to have had great talents, an excellent genius, and profound learning. His ſtyle is grave and polite. Independent of his ſpiritual pride, his morals were exemplary; for he was pious, ſober, chaſte, laborious, and diſintereſted. But his memory can never be purified from the ſtain of burning Servetus: it ill became a reformer to adopt the moſt odious practice of the corrupt church of Rome.

CALVINISM, the doctrine and ſentiments of Calvin and his followers. Calviniſm ſubſiſts in its greateſt purity in the city of Geneva: and from thence it was firſt propagated into Germany, France, the United Provinces, and England. In France it was aboliſhed by the revocation of the edict of Nantz in 1685. It has been the prevailing religion in the United Provinces ever ſince the year 1571. The theological ſyſtem of Calvin was adopted, and made the public rule of faith in England, under the reign of Edward VI. and the church of Scotland was modelled by John Knox, the diſciple of Calvin, agreeably to the doctrine, rites, and form of eccleſiaſtical government, eſtabliſhed at Geneva. In England, it has declined ſince the time of Queen Elizabeth; though it ſtill ſubſiſts, ſome ſay a little allayed, in the articles of the eſtabliſhed church; and in its rigour in Scotland.

The diſtinguiſhing theological tenets of Calviniſm, as the term is now generally applied, reſpect the doctrines of PREDESTINATION, or particular ELECTION and REPROBATION, original SIN, particular REDEMPTION, effectual, or, as ſome have called it, irreſiſtible GRACE in regeneration, JUSTIFICATION by faith, PERSEVERENCE, and the TRINITY. See each of theſe articles.

Beſides the doctrinal part of Calvin's ſyſtem, which, ſo far as it differs from that of other reformers of the ſame period, principally regarded the abſolute decree of God, whereby the future and eternal condition of the human race was determined out of mere ſovereign pleaſure and free will; it extended likewiſe to the diſcipline and government of the Chriſtian church, the nature of the Euchariſt, and the qualification of theſe who were entitled to the participation of it. Calvin conſidered every church as a ſeparate and independent body, inveſted with the power of legiſlation for itſelf. He propoſed that it ſhould be governed by preſbyteries and ſynods, compoſed of clergy and laity, without biſhops, or any clerical ſubordination; and maintained, that the province of the civil magiſtrate extended only to its protection and outward accommodation. In order to facilitate an union with the Lutheran church, he acknowledged a real, though ſpiritual, preſence of Chriſt, in the Euchariſt, that true Chriſtians were united to the man Chriſt in this ordinance, and that divine grace was conferred upon them, and ſealed to them, in the celebration of it; and he confined the privilege of communion to pious and regenerate believers. In France the Calviniſts are diſtinguiſhed by the name of *Huguenots*; and, among the common people, by that of *Parpaillots*. In Germany they are confounded with the Lutherans, under the general title *Proteſtants*; only ſometimes diſtinguiſhed by the name *Reformed*.

CALVINISTS, in church hiſtory, thoſe who follow the opinions of CALVIN. See the two preceding articles.

Crypto-CALVINISTS, a name given to the favourers of Calviniſm in Saxony, on account of their ſecret attachment to the Genevan doctrine and diſcipline. Many of them ſuffered by the decrees of the convocation of Torgaw, held in 1576. The Calviniſts in their progreſs have divided into various branches, or leſſer ſects.

CALVISIUS, Seth, a celebrated German chronologer in the beginning of the 17th century. He wrote *Elenchus calendarii Gregoriani, et duplex calendarii melioris forma*, and other learned works, together with ſome excellent treatiſes on muſic. He died in 1617, aged 61.

CALVITES, or Calvitium, in *Medicine*, baldneſs, or a want of hair, particularly on the ſinciput, occaſioned by the moiſture of the head, which ſhould feed it, being dried up, by ſome diſeaſe, old age, or the immoderate uſe of powder, &c. See Alopecia.

CALUMET, a ſymbolical inſtrument of great importance among the American Indians.—It is nothing more than a pipe, whoſe bowl is generally made of a ſoft red marble: the tube of a very long reed, ornamented with the wings and feathers of birds. No affair of conſequence is tranſacted without the calumet. It ever appears in meetings of commerce or exchanges: in congreſſes for determining of peace or war; and even in the very fury of a battle. The acceptance of the calumet is a mark of concurrence with the terms propoſed; as the refuſal is a certain mark of rejection. Even in the rage of a conflict this pipe is ſometimes offered; and if accepted, the weapons of deſtruction inſtantly drop from their hands, and a truce enſues. It ſeems the ſacrament of the ſavages; for no compact is ever violated which is confirmed by a whiff from this holy reed. When they treat of war, the pipe and all its ornaments are uſually red, or ſometimes red only on one ſide. The ſize and decorations of the calumet are for the moſt part proportioned to the quality of the perſons to whom they are preſented, and to the importance of the occaſion. The calumet of peace is different from that of war. They make uſe of the former to ſeal their alliances and treaties, to travel with ſafety, and to receive ſtrangers; but of the latter to proclaim war. It conſiſts of a red ſtone, like marble, formed into a cavity reſembling the head of a tobacco pipe, and fixed to a hollow reed. They adorn it with feathers of various colours; and name it the calumet of the ſun, to which luminary they preſent it, in expectation of thereby obtaining a change of weather as often as they deſire. From the winged ornaments of the calumet, and its conciliating uſes, writers compare it to the caduceus of Mercury, which was carried by the caduceatores, or meſſengers of peace, with terms to the hoſtile ſtates. It is ſingular, that the moſt remote nations, and the moſt oppoſite in their other cuſtoms and manners, ſhould in ſome things have, as it were, a certain conſent of thought. The Greeks and the Americans had the ſame idea, in the invention of the caduceus of the one, and the calumet of the other.

Dance of the Calumet, is a ſolemn rite among the Indians on various occaſions. They dare not waſh themſelves in rivers in the beginning of ſummer, nor taſte of the new fruits, without performing it; and the ſame ceremony always confirms a peace or precedes a war. It is performed in the winter time in their cabins, and in ſummer in the open fields. For this purpoſe they chooſe a ſpot among trees to ſhade them from the heat of the ſun, and lay in the middle a large mat, as a carpet, ſetting upon it the monitor, or god, of the chief of the company. On the right hand of this image they place the calumet, as their great deity, erecting around it a kind of trophy with their arms. Things being thus diſpoſed, and the hour of dancing come, thoſe who are to ſing take the moſt honourable ſeats under the ſhade of the trees. The company is then ranged round, every one, before he ſits down, ſaluting the monitor, which is done by blowing upon it the ſmoke of their tobacco. Each perſon next receives the calumet in rotation, and holding it with both hands, dances to the cadence of the vocal muſic, which is accompanied with the beating of a ſort of drum. During this exerciſe, he gives a ſignal to one of their warriors, who takes a bow, arrow, and axe, from the trophies already mentioned, and fights him; the former defending himſelf with the calumet only, and both of them dancing all the while. This mock engagement being over, he who holds the calumet makes a ſpeech, in which he gives an account of the battles he has fought, and the priſoners he has taken, and then receives a cloak, or ſome other preſent, from the chief of the ball. He then reſigns the calumet to another, who, having acted a ſimilar part, delivers it to a third, who afterwards gives it to his neighbour, till at laſt the inſtrument returns to the perſon that began the ceremony, who preſents it to the nation invited to the feaſt, as a mark of their friendſhip, and a confirmation of their alliance, when this is the occaſion of the entertainment.

CALUMNY, the crime of accuſing another falſely, and knowingly ſo, of ſome heinous offence.

Oath of Calumny, *Juramentum* (or rather *Juſjurandum*) *Calumniæ*, among civilians and canoniſts, was an oath which both parties in a cauſe were obliged to take; the plaintiff that he did not bring his charge, and the defendant that he did not deny it, with a deſign to abuſe each other, but becauſe they believed their cauſe was juſt and good; that they would not deny the truth, nor create unneceſſary delays, nor offer the judge or evidence any gifts or bribes. If the plaintiff refuſed this oath, the complaint or libel was diſmiſſed; if the defendant, it was taken *pro confeſſo*. This cuſtom was taken from the ancient athletæ; who, before they engaged, were to ſwear that they had no malice, nor would uſe any unfair means for overcoming each other. The *juramentum calumniæ* is much diſuſed, as a great occaſion of perjury. Anciently the advocates and proctors alſo took this oath; but of late it is diſpenſed with, and thought ſufficient that they take it once for all at their firſt admiſſion to practice. See alſo Law, Part III. N° clxxxiv. 7.

CALVUS, Cornelius Licinius, a celebrated Roman orator, was the friend of Catullus; and flouriſhed 64 B. C. Catullus, Ovid, and Horace, ſpeak of him.

CALX properly ſignifies *lime*, but has been uſed by chemiſts and phyſicians for a fine powder remaining after the calcination of metals. All metallic calces are found to weigh more than the metal from which they were originally produced. This ariſes from the metal having combined with oxygen during the proceſs of calcination or burning; and hence in the preſent chemical nomenclature they are called *oxides*.

Calx Nativa, in *Natural Hiſtory*, a kind of marly earth, of a dead whitiſh colour, which, if thrown into water, makes a conſiderable bubbling and hiſſing noiſe, and has, without previous burning, the quality of making a cement like lime or plaſter of Paris.

Calx Viva or *Quick-lime*, that whereon no water has been caſt, in contradiſtinction to lime which has been ſlaked by pouring water on it.

CALYBITES, the inhabitants of a cottage, an appellation given to divers ſaints on account of their long reſidence in ſome hut, by way of mortification.

The word is formed from καλυπτω *tego, I cover* ; whence καλυβη, *a little cot.*—The Romiſh church commemorates St John the Calybite on the 15th of December.

CALYCANTHEMÆ, in *Botany*, an order of plants in the *Fragmenta methodi naturalis* of Linnæus, in which are the following genera, viz. epilobium, œnothera, juſſiæa, ludivigia, oldenlandia, iſnarda, &c. See Botany, *Natural Orders*.

CALYCANTHUS. See Botany *Index*.

CALYCIFLORÆ, in *Botany*, the 16th order in Linnæus's *Fragmenta methodi naturalis*, conſiſting of plants which, as the title imports, have the ſtamina (the flower) inſerted into the calyx. This order contains the following genera, viz. eleagnus, hippophae, oſyris, and trophis. See Botany.

CALYCISTÆ, (from *calyx* the flower-cup), ſyſtematic botaniſts, ſo termed by Linnæus, who have arranged all vegetables from the different ſpecies, ſtructure, and other circumſtances, of the calyx or flower-cup. The only ſyſtems of this kind are the *Character Plantarum Novus*, a poſthumous work of Magnolius, profeſſor of botany at Montpelier, publiſhed in 1720; and Linnæus's *Methodus Calycina*, publiſhed in his *Claſſes Plantarum*, at Leyden, in 1738. See Botany *Hiſtory*.

CALYDON, in *Ancient Geography*, a town of Ætolia, ſituated ſeven miles and a half from the ſea, and divided by the river Evenus ; the country was anciently called *Æolis*, from the Æolians its inhabitants. This country was famous for the ſtory of Meleager and the Calydonian boar.

CALYPSO, in fabulous hiſtory, a goddeſs, who was the daughter of Oceanus and Tethys, or, as others ſay, of Atlas. She was queen of the iſland of Ogygia, which from her was called the iſland of *Calypſo*. According to Homer, Ulyſſes ſuffered ſhipwreck on her coaſt, and ſtaid with her ſeveral years.

CALYPTRA, among botaniſts, a thin membranaceous involucrum, uſually of a conic figure, which covers the parts of fructification. The capſules of moſt of the moſſes have calyptræ.

CALYX, among botaniſts, a general term expreſſing the cup of a flower, or that part of a plant which ſurrounds and ſupports the other parts of the flower.

The cups of flowers are very various in their ſtructure, and on that account diſtinguiſhed by ſeveral names, as *perianthium, involucrum, ſpatha, gluma*, &c. See Botany.

CALZADA, a town of Old Caſtile in Spain, ſeated on the river Leglera. W. Long. 2. 47. N. Lat. 42. 12.

CAMÆA, in *Natural Hiſtory*, a genus of the ſemipellucid gems, approaching to the onyx ſtructure, being compoſed of zones, and formed on a cryſtalline baſis : but having their zones very broad and thick, and laid alternately one on another, with no common matter between ; uſually leſs tranſparent, and more debaſed with earth, than the onyxes.

1. One ſpecies of the camæa is the dull-looking onyx, with broad, black, and white zones ; and is the camæa of the moderns, and the Arabian onyx. This ſpecies is found in Egypt, Arabia, Perſia, and the Eaſt-Indies. 2. Another ſpecies of the camæa is the dull broad-zoned, green and white camæa, or the jaſpicamæo of the Italians : it is found in the Eaſt Indies, and in ſome parts of America. 3. The third is the hard camæa, with broad white and cheſnut-coloured veins. 4. The hard camæa, with bluiſh, white, and fleſh-coloured broad veins, being the ſardonyx of Pliny's time, only brought from the Eaſt Indies.

CAMAIEU, or Camayeu, a word uſed to expreſs a peculiar ſort of onyx : alſo by ſome to expreſs a ſtone, whereon are found various figures, and repreſentations of landſcapes, &c. formed by a kind of *luſus naturæ*, ſo as to exhibit pictures without painting. The word comes from *camahuia*, a name the Orientals give to the onyx, when they find, in preparing it, another colour ; as who ſhould ſay, *a ſecond ſtone*. It is of theſe *camaieux* Pliny is to be underſtood when he ſpeaks of the manifold picture of gems, and the party-coloured ſpots of precious ſtones : *Gemmarum pictura tam multiplex lapidumque tam diſcolores maculæ*.

Camaieu is alſo applied by others to thoſe precious ſtones, as onyxes, cornelians, and agates, whereon the lapidaries employ their art to aid nature, and perfect theſe repreſentations. See Camæa.

Camaieu is alſo frequently applied to any kind of gem, whereon figures may be engraved either indentedly or in relievo. In this ſenſe the lapidaries of Paris are called in their ſtatutes, *cutters of camayeux*.

A ſociety of learned men at Florence undertook to procure all the *cameos* or *camayeux* and intaglios in the great duke's gallery to be engraven ; and began to draw the heads of divers emperors in *cameos*.

Camaieu is alſo uſed for a painting, wherein there is only one colour ; and where the lights and ſhadows are of gold, wrought on a golden or azure ground. When the ground is yellow, the French call it *cirage* ; when gray, *griſſaile*. This kind of work is chiefly uſed to repreſent baſſo relievos : the Greeks call pieces of this ſort μονοχρωματα.

CAMALDULIANS, Camaldunians, or Camaldolites, an order of religious, founded by Romuald, an Italian fanatic, in 1023, in the horrible deſert of Camaldoli, otherwiſe called Campo Malduli, ſituated in the ſtate of Florence, on the Appennines. Their rule is that of St Benedict ; and their houſes, by the ſtatutes, are never to be leſs than five leagues from cities. The *Camaldulians* have not borne that title from the beginning of their order ; till the cloſe of the eleventh century they were called *Romualdins*, from the name of their founder. Till that time, *Camaldulian* was a particular name for thoſe of the deſert Camaldoli ; and D. Grandi obſerves, was not given to the whole order in regard it was in this monaſtery that the order commenced, but becauſe the regulation was beſt maintained here.

Guido Grandi, mathematician of the grand duke of

Tuſcany, and a monk of this order, has publiſhed *Camaldulian* Diſſertations, on the origin and eſtabliſhment of it.

The *Camaldulites* were diſtinguiſhed into two claſſes, of which the one were COENOBITES, and the other EREMITES.

CAMALODUNUM, in *Ancient Geography*, a town of the Trinobantes, the firſt Roman colony in Britain, of veterans under the emperor. From the Itineraries it appears to have ſtood where now Malden ſtands. It continued to be an open place under the Romans; a place of pleaſure rather than ſtrength; yet not unadorned with ſplendid works, as a theatre and a temple of Claudius: which the Britons conſidered as badges of ſlavery, and which gave riſe to ſeveral ſeditions and commotions. It ſtands on a bay of the ſea, at the mouth of the Chelmer, in the county of Eſſex: the modern name is curtailed from the ancient.

CAMARANA, an iſland of Arabia, in the Red ſea, whoſe inhabitants are little and black. It is the beſt of all the iſlands in this ſea, and here they fiſh for coral and pearls. N. Lat. 15. 0.

CAMASSEI, or CAMACE, ANDREA, painter of hiſtory and landſcape, was born at Bevagna, and at firſt learned the principles of deſign and colouring from Domenichino; but afterwards he ſtudied in the ſchool of Andrea Sacchi, and proved a very great painter. He was employed in St Peter's at Rome, as alſo at St John Lateran; and his works are extremely admired, for the ſweetneſs of his colouring, the elegance of his thoughts and deſign, and likewiſe for the delicacy of his pencil. Sandrart laments that the world was deprived of ſo promiſing a genius, in the very bloom of life, when his reputation was daily advancing. He died in 1657. At St John Lateran are to be ſeen, the Battle of Conſtantine and Maxentius; and the Triumph of Conſtantine; which are noble and grand compoſitions; and they afford ſufficient proofs of the happineſs of his invention, and the correctneſs of his execution. Alſo at Wilton, the ſeat of the earl of Pembroke, there is a picture of Venus with the Graces, ſaid to be by the hand of Camaſſei.

CAMARCUM, in *Ancient Geography*, the capital of the Nervii, a people of Gallia Belgica, (Antonine, Peutinger); before whoſe time no mention was made of it. Now Cambray, capital of the Cambreſis, in French Flanders. E. Long. 3. 15. Lat. 50. 15.

CAMARINA, in *Ancient Geography*, a city of Sicily, built by the Syracuſans on an eminence near the ſea, in the ſouth of Sicily, to the weſt of the promontory Pachynum, between two rivers, the Hipparis and Oanus. Of ſo famous a city nothing now remains but its name and ancient walls, a mile and a half in compaſs, with the ſlight remains of houſes: now called *Camarana*.

CAMARINA Palus, a marſh or lake, near the city Camarina, and from which it took its name. In a time of drought, the ſtench of the lake produced a peſtilence; upon which the inhabitants conſulted the oracle, whether they ſhould not quite drain it. The oracle diſſuaded them; they notwithſtanding drained it, and opened a way for their enemies to come and plunder their city: hence the proverb *Ne moveas Camarinam*, that is, not to remove one evil to bring on a greater. Now *Lago di Camarana*, ſituated in a beautiful plain, under the very walls of Camarina, and of a triangular form.

CAMAYEU. See CAMAIEU.

CAMBAIA, or CAMPAY, a town of Aſia, in India, and in the peninſula on this ſide the Ganges; capital of a province of the ſame name; but more commonly called *Guzerat*. It is ſeated at the bottom of a gulf of the ſame name, on a ſmall river; is a large place with high walls, and has a pretty good trade. The product and manufactures are inferior to few towns in India, for it abounds in corn, cattle, and ſilk; and cornelian and agate ſtones are found in its rivers. The inhabitants are noted for embroidery; and ſome of their quilts have been valued at 40l. It is ſubject to the Great Mogul. E. Long. 72. 15. N. Lat. 22. 30.

CAMBAYES, in commerce, cotton cloths made at Bengal, Madras, and ſome other places on the coaſt of Coromandel. They are proper for the trade of Marſeilles, whither the Engliſh at Madras ſend great numbers of them. Many are alſo imported into Holland.

CAMBER, according to our monkiſh hiſtorians, one of the three ſons of Brute, who, upon his father's death, had that part of Britain aſſigned him for his ſhare, called from him *Cambria*, now Wales.

CAMBER-Beam, among builders, a piece of timber in an edifice cut archwiſe, or with an obtuſe angle in the middle, commonly uſed in platforms, as church leads, and on other occaſions where long and ſtrong beams are required.

CAMBERED DECKS, among ſhip-builders. The deck or flooring of a ſhip is ſaid to be cambered, or to lie cambering, when it is higher in the middle of the ſhip's length, and droops towards the ſtem and ſtern, or the two ends. Alſo when it lies irregular; a circumſtance which renders the ſhip very unfit for war.

CAMBERT, a French muſician in the 17th century, was at firſt admired for the manner in which he touched the organ, and became ſuperintendant of the muſic to Anne of Auſtria the queen mother. The Abbé Perin aſſociated him in the privilege he obtained of his majeſty, of ſetting up an opera in 1669. Cambert ſet to muſic two paſtorals, one entitled *Pomona*, the other *Ariadne*, which were the firſt operas given in France. He alſo wrote a piece entitled *The pains and pleaſures of love*. Theſe pieces pleaſed the public; yet in 1672, Lully obtaining the privilege of the opera, Cambert was obliged to come to England, where he became ſuperintendant of the muſic to King Charles II. and died there in 1677.

CAMBIO, an Italian word which ſignifies *exchange*, commonly uſed in Provence, and in ſome other countries, particularly Holland.

CAMBIST, a name given in France to thoſe who trade in notes and bills of exchange. The word *cambiſt*, though a term of antiquity, is even now a technical word, of ſome uſe among merchants, traders, and bankers. Some derive it from the Latin *cambium*, or rather *cambio*.

CAMBLET, or CHAMBLET, a ſtuff ſometimes of wool, ſometimes ſilk, and ſometimes hair, eſpecially that of goats, with wool or ſilk: in ſome, the warp is ſilk and wool twiſted together, and the woof hair.

The true or oriental camblet is made of the pure hair of a ſort of goat, frequent about Angora, and which makes the riches of that city, all the inhabitants whereof are employed in the manufacture and commerce of camblets. It is certain we find mentioned in middle-age writers ſtuſſs made of camels hair, under the denominations of *cameletum* and *camelinum*, whence probably the origin of the term; but theſe are repreſented as ſtrangely coarſe, rough, and prickly, and ſeem to have been chiefly uſed among the monks by way of mortification, as the hair ſhirt of latter times.

We have no camblets made in Europe of the goats hair alone; even at Bruſſels, they find it neceſſary to add a mixture of woollen thread.

England, France, Holland, and Flanders, are the chief places of this manufacture. Bruſſels exceeds them all in the beauty and quality of its camblets: thoſe of England are reputed the ſecond.

Figured Camblets, are thoſe of one colour, whereon are ſtamped various figures, flowers, foliage, &c. by means of hot irons, which are a kind of moulds, paſſed together with the ſtuff under a preſs. Theſe are chiefly brought from Amiens and Flanders; the commerce of theſe was anciently much more conſiderable than at preſent.

Watered Camblets, thoſe which, after weaving, receive a certain preparation with water; and are afterwards paſſed under a hot preſs, which gives them a ſmoothneſs and luſtre.

Waved Camblets, are thoſe whereon waves are impreſſed, as on tabbies; by means of a calendar, under which they are paſſed and repaſſed ſeveral times.

The manufacturers, &c. of camblets are to take care they do not acquire any falſe and needleſs plaits; it being almoſt impoſſible to get them out again. This is notorious even to a proverb; we ſay a perſon is like camblet he has taken his plait.

CAMBODIA, a kingdom of Aſia, in the Eaſt Indies, bounded on the north by the kingdom of Laos, on the eaſt by Cochin-China and Chiapa, and on the ſouth and weſt by the gulf and kingdom of Siam; divided by a large river called *Mecon*. The capital town is of the ſame name, ſeated on the weſtern ſhore of the ſaid river, about 150 miles north of its mouth. This country is annually overflowed in the rainy ſeaſon, between June and October; and its productions and fruits are much the ſame with thoſe uſually found between the tropics. E. Long. 104. 15. N. Lat. 12. 40.

CAMBODUNUM, (Itinerary); a town of the Brigantes in Britain; now in ruins, near Almonbury in Yorkſhire. Weſtcheſter, (Talbot.) Alſo a town of Vindelicia, on the Cambus; now Kempten in Suabia.

CAMBOGIA, in *Botany*: A genus of the monogynia order, belonging to the polyandria claſs of plants; and in the natural method ranking under the 38th order, *Tricoccæ*. The corolla is tetrapetalous; the calyx tetraphyllous; and the fruit is a pome with eight cells, and ſolitary ſeeds. There is but one ſpecies, the gutta, a native of India, which yields the gum-reſin known by the name of *gamboge* in the ſhops. See Gamboge.

CAMBRASINES, in commerce, fine linen made in Egypt, of which there is a conſiderable trade at Cairo, Alexandria, and Roſetta, or Raſchit. They are called *cambraſines* from their reſemblance to cambrics.

CAMBRAY, an archiepiſcopal city, the capital of the Cambreſis, in the Low Countries, ſeated on the Scheldt. It is defended by good fortifications, and has a fort on the ſide of the river; and as the land is low on that ſide, they can lay the adjacent parts under water by means of ſluices. Its ditches are large and deep, and thoſe of the citadel are cut into a rock. Clodion became maſter of Cambray in 445. The Danes burnt it afterwards; ſince which time it became a free imperial city. It has been the ſubject of conteſt between the emperors, the kings of France, and the earls of Flanders. Francis I. let it remain neutral during the war with Charles V. but this laſt took poſſeſſion of it in 1543. After this it was given to John of Montluc by Henry III. of France, whom he created prince of Cambray; but the Spaniards took it from Montluc in 1593, which broke his heart. It continued under the dominion of the houſe of Auſtria till 1677, when the king of France became maſter of it, in whoſe hands it has continued ever ſince.

The buildings of Cambray are tolerably handſome, and the ſtreets fine and ſpacious. The place or ſquare for arms is of an extraordinary largeneſs, and capable of receiving the whole garriſon in order of battle. The cathedral dedicated to the Virgin Mary is one of the fineſt in Europe. The body of the church is very large, and there are rich chapels, the pillars of which are adorned with marble tombs that are of exquiſite workmanſhip, and add greatly to the beauty of the place.

There are two galleries, one of which is of copper, finely wrought. The door of the choir is of the ſame metal, and well carved. The ſteeple of this church is very high, and built in the form of a pyramid; and from its top you have a view of the city, which is one of the fineſt and moſt agreeable in the Low Countries. There are nine pariſhes, four abbeys, and ſeveral convents for both ſexes. The citadel is very advantageouſly ſituated on high ground, and commands the whole city. Cambray is one of the moſt opulent and commercial cities in the Low Countries; and makes every year a great number of pieces of cambric, with which the inhabitants drive a great trade. E. Long. 3. 20. N. Lat. 50. 11.

Cambray, *M. de Fenelon, archbiſhop of.* See Fenelon.

CAMBRESIS, a province of France, in the Netherlands, about 25 miles in length. It is bounded on the north and eaſt by Hainault, on the ſouth by Picardy, and on the weſt by Artois. It is a very fertile and populous country; and the inhabitants are induſtrious, active, and ingenious. The trade conſiſts principally in corn, ſheep, very fine wool, and fine linen cloth. Cambray is the capital town.

CAMBRIA, a name for the principality of Wales.

CAMBRIC, in commerce, a ſpecies of linen made of flax, very fine and white; the name of which was originally derived from the city of Cambray, where they were firſt manufactured. They are now made at other places in France.

The manufacture of cambrics hath long ſince proved of extraordinary advantage to France. For many years it appeared that England did not in this article contribute leſs than 200,000l. per annum to the intereſt of France. This proved motive ſufficient to induce the parliament of Great Britain to enact many ſalutary laws to prevent this great loſs of our wealth. See 18 Geo. II. c. 38. and 21 Geo. II. c. 26 See alſo ſtat. 32. Geo. II. c. 32. and 4 Geo. III. c. 37. which regulates the cambric manufactory, not long ſince introduced into Winchelſea in Suſſex; but very ſoon aboliſhed. The cambrics now allowed in this country are manufactured in Scotland and Ireland. Any perſons convicted of wearing, ſelling (except for exportation), or making up for hire any cambric or French lawns, are liable to a penalty of 5l. by the two firſt ſtatutes cited above.

CAMBRIDGE, a town of England, and capital of the county of that name. It takes the name of Cambridge from the bridge over the Cam, which divides the town into two parts. Either it or a place in the neighbourhood was ſtyled *Camboritum*, in the time of the Romans. It ſuffered much during the wars with the Danes. Here was a caſtle built by William the Conqueror, of which the gatehouſe yet remains, and is now the county gaol. By Doomſday-book it appears that it then had ten wards, containing 387 houſes. In William Rufus's reign it was quite deſtroyed by Roger de Montgomery; but Henry I. beſtowed many privileges upon it to encourage its reſtoration, particularly an exemption from the power of the ſheriff, on condition of its paying yearly into the exchequer 100 merks (equivalent to 1000 pounds now), and from tolls, laſtage, pontage, paſſage, and ſtallage, in all fairs of his dominions. It was afterwards often plundered in the barons wars by the outlaws from the iſle of Ely, till Henry III. ſecured it by a deep ditch. In 1388, Richard II. held a parliament here. In the rebellion of Wat Tyler and Jack Straw againſt that prince, the univerſity records were taken and burnt in the market place.

The modern town is about one mile long from ſouth to north, and about half a mile broad in the middle, diminiſhing at the extremities. It has 14 pariſh churches, of which two are without any towers. It contains above 1200 houſes; but the private buildings are neither elegant nor large, owing chiefly to their being held on college or corporation leaſes. It is governed by a mayor, high ſteward, recorder, 13 aldermen and 24 common council men, a town clerk, &c. Its chief trade is water carriage from hence to Downham, Lynn, Ely, &c. The Jews being encouraged to ſettle in England by William I. and II. were very populous here for ſeveral generations, and inhabited that ſtreet now called the *Jewry*. They had a ſynagogue, ſince converted to a pariſh church, called from the ſhape of its tower *Round Church*; though others are of opinion that it was built by the Knights Templars, it bearing a reſemblance to the Temple church in London. The market place is ſituated in the middle of the town, and conſiſts of two ſpacious oblong ſquares united together; at the top of the angle ſtands the ſhire hall, lately erected at the expence of the county. At the back of the ſhire hall is the town hall and gaol. In the market place, fronting the ſhire hall, is a remarkably handſome ſtone conduit, to which water is conveyed by an aqueduct, which was the benefaction of the celebrated Hobſon, a carrier in the reign of James I. who was a native of this town. A fine road for the benefit of the inhabitants and ſtudents was made a few years ſince for four miles, from this town to Gogmagog hills, purſuant to the will of Mr Worts. The late Dr Addenbroke alſo left it 4000l. towards building and furniſhing an hoſpital for the cure of poor diſeaſed people gratis; of which charity the maſter of Catharine hall is a truſtee; which hoſpital has been erected at the ſouth-eaſt end of the town. At a little diſtance from Bennet college is the botanic garden of five acres, and a large houſe for the uſe of the governors and the reſidence of the curator, given to the univerſity by the late Dr Walker, who ſettled an eſtate on it towards its ſupport, to which the late Mr Edward Betham added a very conſiderable benefaction. The town has fairs on June 24. and Auguſt 14.

The glory of Cambridge is its univerſity; but when it had its beginning is uncertain. At firſt there was no public proviſion for the accommodation or maintenance of the ſcholars; but afterwards inns began to be erected by pious perſons for their reception, and in the time of Edward I. colleges began to be built and endowed. This univerſity, not inferior to any in Chriſtendom, conſiſts of 12 colleges and 4 halls, which have the ſame privileges as the colleges. The whole body, which is commonly about 1500, enjoys very great privileges granted by ſeveral of our ſovereigns; but it was James I. who empowered it to ſend two members to parliament, as the town had done from the firſt. The univerſity is governed, 1. By a chancellor, who is always ſome nobleman, and may be changed every three years, or continued longer by the tacit conſent of the univerſity. 2. By a high ſteward, choſen by the ſenate, and holding his place by patent from the univerſity. 3. By a vice-chancellor, who is the head of ſome college or hall, and choſen yearly by the body of the univerſity, the heads of the colleges naming two. 4. By two proctors choſen every year, according to the cycle of colleges and halls; as are two taxors, who with the proctors regulate the weights and meaſures, as clerks of markets. The proctors alſo inſpect the behaviour of the ſcholars, who muſt not be out of their colleges after nine at night. Here are alſo 2 moderators, 2 ſcrutators, a commiſſary, public orator, 2 librarians, a regiſter, a ſchool-keeper, 3 eſquire beadles and a yeoman beadle, 18 profeſſors, and the caput, conſiſting of the vice-chancellor, a doctor of divinity, a doctor of laws, a doctor of phyſic, a regent and a non-regent maſter of arts. Henry VI. granted it the power to print all books of any kind within itſelf, a privilege which Oxford had not. The ſenate houſe of the univerſity is an elegant building of the Corinthian order, coſt near 16,000l. building; in which on the north ſide is a fine ſtatue of George I. erected in 1739 at the expence of the late Lord Townſhend; oppoſite to this on the ſouth ſide is another of George II. erected in 1765 at the expence of the late duke of Newcaſtle: at the eaſt end, on each ſide of the entrance, are two others; one, the late duke of Somerſet, after the Vandyke taſte; the other, an Italian emblematical figure of Gloria. This is allowed to be the moſt ſuperb room in England, being 101 feet long, 42 broad, and 32 high; and it has a gallery which can contain 1000 perſons. This building forms the north ſide of the quadrangle, as the ſchools and public library do the weſt, the ſchools being the ground floor, and the library over them ſurrounding a ſmall court. North of the philoſophy ſchool is the repoſitory of Dr Woodward's foſſils, ores, ſhells, &c. The doctor, together with that collection, and a part of his library, left a ſum of money to this univerſity for erecting a profeſſorſhip for natural philoſophy, with a proviſion of 150l. a-year for ever. At the ſouth-eaſt corner of this building is an elegant geometrical ſtone ſtaircaſe which leads to the old library, and conſiſts of 18 claſſes; at the end of which is an elegant ſquare room, in which are depoſited the MSS. and a valuable cabinet of oriental books and curioſities, &c. This room opens to two other rooms, containing 26 large claſſes, conſiſting of 30,000 volumes preſented to the univerſity by George I. being the entire collection of Dr Moore, biſhop of Ely, and purchaſed of the doctor's executors by his majeſty for 6000 guineas; before which his majeſty gave the univerſity 2000l. to defray the expence of fitting up the apartments, and erecting claſſes for their reception; they conſiſt of the firſt editions of the Greek and Latin claſſics and hiſtorians, and the greateſt part of the works of the firſt printers; large collections of prints by the greateſt maſters; and a valuable MS. of the Goſpels and Acts of the Apoſtles, on vellum, in Greek and Latin capitals, given to the univerſity by Theodore Beza, and ſuppoſed to be as old as any MS. extant. The other part of the library has been rebuilt in an elegant manner, and forms the weſt ſide of the intended quadrangle. The books which are contained in the laſt room are part of the old library augmented with a conſiderable number of the beſt modern books, ſeveral of which are preſents from foreign ſovereigns and eminent men. The ſouth ſide of the quadrangle is deſigned for a building to contain the printing-office, &c. of the univerſity, for which preparations began lately to be made by pulling down the old buildings on the ſpot. St Mary's church forms the eaſt ſide of this quadrangle: here the univerſity have their public ſermons; and the pulpit, which ſtands in the centre of the church, and faces the chancel, has no foundingboard. In a grand gallery over part of the chancel is a ſeat for the chancellor, vice-chancellor, &c. George I. when he gave the books, alſo eſtabliſhed a profeſſor of modern hiſtory and modern languages in this univerſity, with a ſalary of 400l. for himſelf and two perſons under him, qualified to inſtruct in that branch 20 ſcholars, to be nominated by the king, each of whom is obliged to learn at leaſt two of the languages. A fellowſhip is founded at Magdalen college, appropriated to the gentlemen of Norfolk, and called *the travelling Norfolk fellowſhip.* All the libraries in Cambridge, except that of King's college, are lending libraries: and thoſe at Oxford are ſtudying libraries. The different colleges are as follow:

1. St Peter's, the moſt ancient, and the firſt on entering the town from London, conſiſting of two courts, ſeparated by a cloiſter and gallery. The largeſt is 144 feet long, and 84 broad. The buildings in this court have been lately repaired in an elegant manner. The leſſer court is divided by the chapel, which is a fine old building, 54 feet long, 27 broad, and 27 high. This college was founded 1257. There are three colleges in Oxford, which diſpute the antiquity with this: Cambridge and Oxford were univerſities long before they were poſſeſſed of any colleges in their own right, the ſtudents then lodging and boarding with the townſmen, and they then hired hotels for their exerciſes and diſputations. A hotel or hall, now denominated *Pythagoras's ſchool*, ſituated on the weſt ſide of the river, is one of the ancient hotels that remain undemoliſhed, and in which Eraſmus read his firſt Greek lectures in England. 2. Clare hall, on the bank of the river, over which it has an elegant ſtone bridge, was founded 1326, conſiſting of one grand court, 150 feet long, and 111 broad. The front of this building that faces the fields has the appearance of a palace. To this college a new chapel has been added. 3. Pembroke hall is near St Peter's college, and was founded in 1348; it conſiſts of two courts. It has an elegant chapel, built by Sir Chriſt. Wren. 4. Corpus Chriſti or Bennet college, founded in 1350, has but a mean appearance, but is poſſeſſed of a remarkably large collection of valuable and curious ancient manuſcripts. 5. Trinity hall, on the north of Clare hall, near the river, was founded in 1351; it is a ſmall but remarkably neat building. 6. Gonvil and Caius college is near the middle of the town, north of the ſenate houſe, and has three courts. It was founded 1348, and augmented 1557. 7. King's college, the moſt noble foundation in Europe, was firſt endowed by Henry VI. The old court reſembles a decayed caſtle, more than a college. The new building is very magnificent, near 300 feet long. The chapel is one of the fineſt pieces of Gothic architecture now remaining in the world. It is 304 feet long, 73 broad on the outſide, and 40 within, and 91 high; and yet not a ſingle pillar to ſuſtain its ponderous roofs, of which it has two: the firſt is of ſtone, moſt curiouſly carved; the other of wood, covered with lead, between which is a vacancy of 10 feet. There is ſuch a profuſion of carvings, both within and without, as is nowhere to be equalled. Henry VII. enlarged it 188 feet in length, and Henry VIII. gave the elegant ſtalls and organ gallery, with its inimitable carvings, where are the coats of arms of that king and thoſe of Anne Boleyn quartered. He gave alſo the elegant painted glaſs windows, which are in fine preſervation, and were permitted by Cromwell to be preſerved when almoſt every other in England was deſtroyed, as he had a particular regard for this univerſity, where he had his education, and for the town which he had repreſented in parliament. A new altar has been lately erected, which correſponds with the architecture of the building, embelliſhed with an antique painting of Chriſt taking down from the croſs, purchaſed in Italy, and preſented to the college by the earl of Carliſle. In this chapel are put up the Spaniſh colours taken at the reduction of Manilla by Colonel Draper, a member of this college. This college has an ancient ſtone bridge over the Cam. 8. Queen's college, near the river, ſouth of King's, was founded 1448, and conſiſts of two courts, with a fine grove, and gardens on both ſides of the river, connected with each other and the college by two wooden bridges, one of which is of a curious ſtructure. 9. Catharine hall is eaſt of Queen's, and its principal front on the weſt,

Cambridge.

weſt, the moſt extenſive and regular in the univerſity. It contains only one court, 180 feet long, and 120 broad, and was founded in 1475. 10. Jeſus college is at the eaſt end of the town, ſurrounded by groves and gardens. The principal front faces the ſouth, 180 feet long, regularly built and ſaſhed: it was originally a Benedictine convent, and converted to the preſent uſe 1576. 11. Chriſt's college is oppoſite to St Andrew's church, on the eaſt ſide of the town; and was founded by Henry VIIth's mother, in 1505. It has lately had a thorough repair, and is now a neat and beautiful ſtructure. 12. St John's college was founded by the ſame lady, in 1509, on the ſite of a diſſolved priory. It conſiſts of three courts, and has a large library filled with ſcarce and valuable books. To this college belongs a fine ſtone bridge over the river, which leads to their grand walks. 13. Magdalen college, the only one that ſtands on the north ſide of the river, near the great bridge, conſiſts of two courts, and was founded in 1519. 14. Trinity college is eaſt of the river, having St John's college on the north, and Caius's college and Trinity hall on the ſouth. It contains two large quadrangles, the firſt of which is 344 feet long, and 280 broad. It has two noble entrances; and on the north ſide of it is the chapel, 204 feet long, 34 broad, and 44 high. It has every grand ornament, and the much admired ſtatue of Sir Iſaac Newton, who was a ſtudent in this college. The hall is above 100 feet long, 40 broad, and 50 high. The inner court is eſteemed the fineſt in the univerſity, and ſurpaſſes any in Oxford. It is very ſpacious, and has an elegant cloiſter of ſtone pillars, ſupporting grand apartments; on the weſt is the library, the moſt elegant ſtructure of the kind in the kingdom, 190 feet long, 40 broad, and 38 high within. Its entrance is by a ſtaircaſe, the ſteps black marble, and the walls incruſted with ancient Roman monuments. The entrance into the library is by folding doors at the north end. Its inſide appearance is inexpreſſibly grand, having at the ſouth end (lately erected) a beautiful painted glaſs window of his preſent majeſty in his robes; and the claſſes are large, beautiful, and noble, well ſtocked with books, manuſcripts, &c. Its outſide has every ſuitable embelliſhment, and was erected by Sir Chriſtopher Wren, at the expence of near 20,000l. Under this building is a ſpacious piazza of equal dimenſions; out of which open three gates to a lawn that leads to the river, over which is a new elegant cycloidal bridge of three arches, leading to extenſive walks. In the middle is a remarkable viſta. This college was founded on the ſite of two other colleges and a hall in 1546, by Henry VIII. 15. Emanuel college is at the ſouth-eaſt end of the town; conſiſts of two courts, the principal of which is very neat; and was built on the ſite of a Dominican convent. It has been lately in a great part rebuilt and elegantly embelliſhed. 16. Sidney-Suſſex college is in Bridge-ſtreet. Its hall is elegant, but the chapel remarkable only for ſtanding north and ſouth, as others do eaſt and weſt. The number of inhabitants in the town of Cambridge in 1801, was 10,087.

Cambridgeſhire,
New Cambridge.

CAMBRIDGESHIRE, an inland county of England, bounded on the eaſt by Norfolk and Suffolk, on the ſouth by Eſſex and Hertfordſhire, on the weſt by Bedfordſhire and Huntingdonſhire, and on the north by Lincolnſhire. Prior to the arrival of the Romans it was included in the ancient diviſion of the Iceni; and after their conqueſt, in the third province of Flavia Cæſarienſis, which reached from the Thames to the Humber. During the Heptarchy it belonged to the kingdom of Eaſt Angles, the ſixth kingdom, which began in 575, and ended in 792, having had 14 kings; and it is now included in the Norfolk circuit, the dioceſe of Ely, and province of Canterbury, except a ſmall part which is in the dioceſe of Norwich. It is about 40 miles in length from north to ſouth, and 25 in breadth from eaſt to weſt, and is 130 miles in circumference, containing near 570,000 acres. It has about 17,400 houſes, 140,000 inhabitants: is divided into 17 hundreds, in which are one city, Ely; 8 market towns, viz. Cambridge, which is the ſhire town, and a celebrated univerſity, Caxton, Linton, Merch, Newmarket, Soham, Wiſbeach, Thorney, and part of Royſton; 220 villages, 64 pariſhes: ſends 2 members to parliament (excluſive of 2 for the town, and 2 for the univerſity), pays one part of the land tax, and provides 480 men in the militia. Its only rivers are the Cam, the Nene, and the Ouſe. A conſiderable tract of land in this county is diſtinguiſhed by the name of the Iſle of Ely. It conſiſts of fenny ground, divided by innumerable channels and drains: and is part of a very ſpacious level, containing 300,000 acres of land, extending into Norfolk, Suffolk, Huntingdonſhire, and Lincolnſhire. The Iſle of Ely is the north diviſion of the county, and extends ſouth almoſt as far as Cambridge. The whole level of which this is part, is bounded on one ſide by the ſea, and on the others by uplands; which taken together, form a rude kind of ſemicircle, reſembling a horſe ſhoe. The air is very different in different parts of the country. In the fens it is moiſt and foggy, and therefore not ſo wholeſome; but in the ſouth and eaſt parts it is very good, theſe being much drier than the other: but both, by late improvements, have been rendered very fruitful, the former by draining, and the latter by cinquefoil: ſo that it produces plenty of corn, eſpecially barley, ſaffron, and hemp, and affords the richeſt paſtures. The rivers abound with fiſh, and the fens with wild fowl. The principal manufactures of the county are malt, paper, and baſkets. As the above tract appears to have been dry land formerly, the great change it has undergone muſt have been owing either to a violent breach and inundation of the ſea, or to earthquakes. As the towns in and about the fens were great ſufferers by the ſtagnation of the waters in ſummer, and want of proviſions in winter, many attempts were made to drain them, but without ſucceſs, until the time of Charles I. in which, and that of his ſon, the work was happily completed, and an act of parliament paſſed, by which a corporation was eſtabliſhed for its preſervation and government. By the ſame act, 83,000 acres were veſted in the corporation, and 10,000 in the king. In theſe fens are a great many DECOYS, in which incredible numbers of ducks, and other wild fowl, are caught during the ſeaſon. The population of the county of Cambridge, as it was taken in 1801, amounted to 89,349 perſons.

New CAMBRIDGE, a town of New England, about

three

Cambridge. three miles from Boſton, remarkable for an univerſity conſiſting of three colleges. W. Long. 70. 4. N. Lat. 42. 0.

CAMBRIDGE *Manuſcript*, a copy of the Goſpels and Acts of the Apoſtles in Greek and Latin. Beza found it in the monaſtery of Irenæus at Lyons in the year 1562, and gave it to the univerſity of Cambridge in 1582. It is a quarto ſize, and written on vellum; 66 leaves of it are much torn and mutilated, ten of which are ſupplied by a later tranſcriber. Beza conjectures, that this manuſcript might have exiſted ſo early as the time of Irenæus: Wetſtein apprehends that it either returned or was firſt brought from Egypt into France; that it is the ſame copy which Druthmar, an ancient expoſitor who lived about the year 840, had ſeen, and which, he obſerves, was aſcribed to St Hilary; and that R. Stephens had given a particular account of it in his edition of the New Teſtament in 1550. It is uſually called *Stephen's ſecond Manuſcript*. Mill agrees with F. Simon in opinion, that it was written in the weſtern part of the world by a Latin ſcribe, and that it is to a great degree interpolated and corrupted: he obſerves that it agrees ſo much with the Latin Vulgate, as to afford reaſon for concluding, that it was corrected or formed upon a corrupt and faulty copy of that tranſlation. From this and the Clermont copy of St Paul's Epiſtles, Beza publiſhed his larger Annotations in 1582.

CAMBYSES. See *(Hiſtory of)* PERSIA.

Camden.

CAMDEN, WILLIAM, the great antiquarian, was born in London in the year 1551. His father was a native of Litchfield in Staffordſhire, who ſettling in London, became a member of the company of paperſtainers, and lived in the Old Bailey. His mother was of the ancient family of Curwen, of Workington, in Cumberland. He was educated firſt at Chriſt's hoſpital, and afterwards at St Paul's ſchool: from thence he was ſent, in 1566, to Oxford, and entered ſervitor of Magdalen college; but being diſappointed of a demy's place, he removed to Broadgate hall, and ſomewhat more than two years after to Chriſt-church, where he was ſupported by his kind friend and patron Dr Thornton. About this time he was a candidate for a fellowſhip of All-ſouls college, but loſt it by the intrigues of the Popiſh party. In 1570, he ſupplicated the regents of the univerſity to be admitted bachelor of arts; but in this alſo he miſcarried. The following year Mr Camden came to London, where he proſecuted his favourite ſtudy of antiquity, under the patronage of Dr Goodman, dean of Weſtminſter, by whoſe intereſt he was made ſecond maſter of Weſtminſter ſchool in 1575. From the time of his leaving the univerſity to this period, he took ſeveral journeys to different parts of England, with a view to make obſervations and collect materials for his *Britannia*, in which he was now deeply engaged. In 1581 he became intimately acquainted with the learned Preſident Briſſon who was then in England; and in 1586 he publiſhed the firſt edition of his Britannia; a work which, though much enlarged and improved in future editions, was even then eſteemed an honour to its author, and the glory of its country. In 1593 he ſucceeded to the head maſterſhip of Weſtminſter ſchool on the reſignation of Dr Grant. In this office he continued till 1597, when he was promoted to be Clarencieux king at arms. In the year 1600 Mr Camden made a tour to the north, as far as Carliſle, accompanied by his friend Mr (afterwards Sir Robert) Cotton. In 1606 he began his correſpondence with the celebrated Preſident de Thou, which continued to the death of that faithful hiſtorian. In the following year he publiſhed his laſt edition of the Britannia, which is that from which the ſeveral Engliſh tranſlations have been made; and in 1608, he began to digeſt his materials for a hiſtory of the reign of Queen Elizabeth In 1609, after recovering from a dangerous illneſs, he retired to Chiſlehurſt in Kent, where he continued to ſpend the ſummer months during the remainder of his life. The firſt part of his annals of the queen did not appear till the year 1615, and he determined that the ſecond volume ſhould not appear till after his death (A). The work was entirely finiſhed in 1617; and from that time he was principally employed in collecting more materials for the further improvement of his Britannia. In 1622, being now upwards of 70, and finding his health decline apace, he determined to loſe no time in executing his deſign of founding a hiſtory lecture in the univerſity of Oxford. His deed of gift was accordingly tranſmitted by his friend Mr Heather to Mr Gregory Wheare, who was, by himſelf, appointed his firſt profeſſor. He died at Chiſlehurſt in 1623, in the 73d year of his age; and was buried with great ſolemnity in Weſtminſter abbey in the ſouth aiſle, where a monument of white marble was erected to his memory. Camden was a man of ſingular modeſty and integrity; profoundly learned in the hiſtory and antiquities of this kingdom, and a judicious and conſcientious hiſtorian. He was reverenced and eſteemed by the literati of all nations, and will be ever remembered as an honour to the age and country wherein he lived. Beſides the works already mentioned, he was author of an excellent Greek grammar, and of ſeveral tracts in Hearne's collection. But his great and moſt uſeful work, the *Britannia*, is that upon which his fame is chiefly built. The edition above mentioned, to which he put his laſt hand, was correctly printed in folio, much augmented, amended where it was neceſſary, and adorned with maps. It was firſt tranſlated into Engliſh, and publiſhed in folio at London, in 1611, by the laborious Dr Philemon Holland, a phyſician of Coventry, who is thought to have conſulted our author himſelf; and therefore great reſpect has been paid to the additions and explanations that

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(A) The reign of Queen Elizabeth was ſo recent when the firſt volume of the Annals was publiſhed, that many of the perſons concerned, or their dependents, were ſtill living. It is no wonder, therefore, that the honeſt hiſtorian ſhould offend thoſe whoſe actions would not bear inquiry. Some of his enemies were clamorous and troubleſome; which determined him not to publiſh the ſecond volume during his life; but that poſterity might be in no danger of diſappointment, he depoſited one copy in the Cotton library, and tranſmitted another to his friend Dupuy at Paris. It was firſt printed at Leyden in 1625.

occur therein, on a ſuppoſition that they may belong to Camden. But in a later edition of the ſame tranſlation, publiſhed in 1636, the Doctor has taken liberties which cannot either be defended or excuſed. A new tranſlation, made with the utmoſt fidelity from the laſt edition of our author's work, was publiſhed in 1695, by Edmund Gibſon of Queen's college in Oxford, afterwards biſhop of London ; in which, beſides the addition of notes, and of all that deſerved to be taken notice of in Dr Holland's firſt edition, which, though thrown out of the text, is preſerved at the bottom of the page, there are many other augmentations and improvements, all properly diſtinguiſhed from the genuine work of the author, as they ought to be : and the ſame judicious method obtained in the next edition of the ſame performance, which was juſtly conſidered as the very beſt book of its kind that had been hitherto publiſhed. But the public has been recently put in poſſeſſion of a new tranſlation, and ſtill more improved edition, by that learned and induſtrious topographer Mr Gough, under whoſe hands it has been enlarged to near double the ſize of the laſt of the preceding editions.

CAMEL, in *Zoology*. See CAMELUS.

CAMEL, in *Mechanics*, a kind of machine uſed in Holland for raiſing or lifting ſhips, in order to bring them over the Pampus, which is at the mouth of the river Y, where the ſhallowneſs of the water hinders large ſhips from paſſing. It is alſo uſed in other places, particularly at the dock of Peterſburgh, the veſſels built here being in their paſſage to Cronſtadt lifted over the bar by means of camels. Theſe machines were originally invented by the celebrated De Wit, for the purpoſe above mentioned ; and were introduced into Ruſſia by Peter the Great, who obtained the model of them when he worked in Holland as a common ſhipwright. A camel is compoſed of two ſeparate parts, whoſe outſides are perpendicular, and whoſe inſides are concave, ſhaped ſo as to embrace the hull of a ſhip on both ſides. Each part has a ſmall cabin with ſixteen pumps and ten plugs, and contains 20 men. They are braced to a ſhip underneath by means of cables, and entirely encloſe its ſides and bottom ; being then towed to the bar, the plugs are opened, and the water admitted until the camel ſinks with the ſhip and runs aground. Then, the water being pumped out, the camel riſes, lifts up the veſſel, and the whole is towed over the bar. This machine can raiſe the ſhip eleven feet, or, in other words, make it draw eleven feet leſs water.

CAMELFORD, a borough town of Cornwall in England, conſiſting of about 100 houſes, badly built ; but the ſtreets are broad and well paved. W. Long. 5. 4. N. Lat. 50. 40. It ſends two members to parliament ; and gives title of baron to Thomas Pitt, elder brother of the great earl of Chatham.

CAMELIA. See BOTANY *Index*.

CAMELODUM. See CAMALODUNUM.

CAMELOPARDALIS, in *Zoology*, the trivial name of a ſpecies of CERVUS. See MAMMALIA *Index*.

CAMELUS, or CAMEL, in *Zoology*, a genus of quadrupeds belonging to the order of pecora. See MAMMALIA *Index*.

CAMEO. See CAMAIEU.

CAMERA ÆOLIA, a contrivance for blowing the fire, for the fuſion of ores, without bellows ; by means of water falling through a funnel into a cloſe veſſel, which ſends from it ſo much air or vapour as continually blows the fire : if there be the ſpace of another veſſel for it to expatiate in by the way, it there lets fall its humidity, which otherwiſe might hinder the work. This contrivance was named *camera Æolia* by Kircher.

CAMERA *Lucida*, a contrivance of Dr Hook for making the image of any thing appear on a wall in a light room, either by day or night. Oppoſite to the place or wall where the appearance is to be, make a hole of at leaſt a foot in diameter, or if there be a high window with a caſement of this dimenſion in it, this will do much better without ſuch hole or caſement opened.

At a convenient diſtance, to prevent its being perceived by the company in the room, place the object or picture intended to be repreſented, but in an inverted ſituation. If the picture be tranſparent, reflect the ſun's rays by means of a looking glaſs, ſo as that they may paſs through it towards the place of repreſentation ; and, to prevent any rays from paſſing aſide it, let the picture be encompaſſed with ſome board or cloth. If the object be a ſtatue, or a living creature, it muſt be much enlightened by caſting the ſun's rays on it, either by reflection, refraction, or both. Between this object and the place of repreſentation put a broad convex glaſs, ground to ſuch a convexity as that it may repreſent the object diſtinctly in ſuch place. The nearer this is ſituated to the object, the more will the image be magnified on the wall, and the further the leſs : ſuch diverſity depending on the difference of the ſpheres of the glaſſes. If the object cannot be conveniently inverted, there muſt be two large glaſſes of proper ſpheres, ſituated at ſuitable diſtances, eaſily found by trial, to make the repreſentations erect. This whole apparatus of object, glaſſes, &c. with the perſons employed in the management of them, are to be placed without the window or hole, ſo that they may not be perceived by the ſpectators in the room, and the operation itſelf will be eaſily performed. Phil. Tranſ. N° 38. p. 741. ſeq.

CAMERA *Obſcura*, or *Dark Chamber*, in *Optics*, a machine, or apparatus, repreſenting an artificial eye ; whereon the images of external objects, received through a double convex glaſs, are exhibited diſtinctly, and in their native colours, on a white matter placed within the machine, in the focus of the glaſs.

The firſt invention of this inſtrument is aſcribed to Baptiſta Porta. See his *Magia Naturalis*, lib. xvii. cap. 6. firſt publiſhed at Frankfort about the year 1589 or 1591 ; the firſt four books of this work were publiſhed at Antwerp in 1560.

The *camera obſcura* affords very diverting ſpectacles ; both by exhibiting images perfectly like their objects, and each clothed in their native colours ; and by expreſſing, at the ſame time, all their motions ; which latter no other art can imitate. By means of this inſtrument, a perſon unacquainted with deſigning will be able to delineate objects with the greateſt accuracy and juſtneſs, and another well verſed in painting will find many things herein to perfect his art. See the conſtruction under DIOPTRICS.

CAMERARIA. See Botany *Index*.

CAMERARIUS, Joachim, one of the moſt learned writers of his time, was born in 1500, at Bamberg, a city of Franconia; and obtained great reputation by his writings. He tranſlated into Latin Herodotus, Demoſthenes, Xenophon, Euclid, Homer, Theocritus, Sophocles, Lucian, Theodoret, Nicephorus, &c. He publiſhed a catalogue of the biſhops of the principal ſees; Greek epiſtles; Accounts of his journies, in Latin verſe; a Commentary on Plautus; the Lives of Helius Eobanus Heſſus, and Philip Melancthon, &c. He died in 1574.

Camerarius, *Joachim*, ſon of the former, and a learned phyſician, was born at Nuremberg in 1534. After having finiſhed his ſtudies in Germany, he went into Italy, where he obtained the eſteem of the learned. At his return he was courted by ſeveral princes to live with them; but he was too much devoted to books, and the ſtudy of chemiſtry and botany, to comply. He wrote a Hortus Medicus, and ſeveral other works. He died in 1598.

CAMERATED, among builders, the ſame with vaulted or arched.

CAMERET bay, in the province of Brittany in France, forms the harbour of Breſt. See Brest.

CAMERINO, a town of the eccleſiaſtical ſtate in Italy, ſituated in E. Long. 13. 7. N. Lat. 45. 6.

CAMERLINGO, according to Du Cange, ſignified formerly the pope's or emperor's treaſurer: at preſent, camerlingo is nowhere uſed but at Rome, where it denotes the cardinal who governs the eccleſiaſtical ſtate, and adminiſters juſtice. It is the moſt eminent office at the court of Rome, becauſe he is at the head of the treaſury. During a vacation of the papal chair, the cardinal camerlingo publiſhes edicts, coins money, and exerts every other prerogative of a ſovereign prince; he has under him a treaſurer-general, auditor-general, and 12 prelates called *clerks of the chamber*.

CAMERON, John, one of the moſt famous divines among the Proteſtants of France in the 17th century, was born at Glaſgow in Scotland, where he taught the Greek tongue; and having read lectures upon that language for about a year, travelled, and became profeſſor at ſeveral univerſities, and miniſter at Bourdeaux. He publiſhed, 1. Theological lectures; 2. *Icon Johannis Cameronis*; and ſome miſcellaneous pieces. He died in 1625, aged 60.

CAMERONIANS, a ſect or party in Scotland, who ſeparated from the Preſbyterians in 1666, and continued to hold their religious aſſemblies in the fields.

The Cameronians took their denomination from Richard Cameron, a famous field preacher, who refuſing to accept the indulgences to tender conſciences, granted by King Charles II. as ſuch an acceptance ſeemed an acknowledgment of the king's ſupremacy, and that he had before a right to ſilence them, made a defection from his brethren, and even headed a rebellion, in which he was killed. His followers were never entirely reduced till the Revolution, when they voluntarily ſubmitted to King William.

The Cameronians adhered rigidly to the form of government eſtabliſhed in 1648.

Cameronians, or *Cameronites*, is alſo the denomination of a party of Calviniſts in France, who aſſerted that the will of a man is only determined by the practical judgment of the mind; that the cauſe of men's doing good or evil proceeds from the knowledge which God infuſes into them; and that God does not move the will phyſically, but only morally, in virtue of its dependence on the judgment of the mind. They had this name from John Cameron, a famous profeſſor, firſt at Glaſgow, where he was born, in 1580, and afterwards at Bourdeaux, Sedan, and Saumur; at which laſt place he broached his new doctrine of grace and free will, which was formed by Amyraut, Cappel, Bochart, Daille, and others of the more learned among the reformed miniſters, who judged Calvin's doctrines on theſe points too harſh. The Cameronians are a ſort of mitigated Calviniſts, and approach to the opinion of the Arminians. They are alſo called *Univerſaliſts*, as holding the univerſality of Chriſt's death; and ſometimes *Amyraldiſts*. The rigid adherents to the ſynod of Dort accuſed them of Pelagianiſm, and even of Manicheiſm. The controverſy between the parties was carried on with a zeal and ſubtilty ſcarce conceivable; yet all the queſtion between them was only, Whether the will of man is determined by the immediate action of God upon it, or by the intervention of a knowledge which God impreſſes into the mind? The ſynod of Dort had defined that God not only illuminates the underſtanding, but gives motion to the will by making an internal change therein. Cameron only admitted the illumination, whereby the mind is morally moved; and explained the ſentiment of the ſynod of Dort ſo as to make the two opinions conſiſtent.

CAMES, a name given to the ſmall ſlender rods of caſt lead of which the glaziers make their turned lead.

Their lead being caſt into ſlender rods of twelve or fourteen inches long each, is called the *came*; ſometimes alſo they call each of theſe rods a *came*, which being afterwards drawn through their vice, makes their turned lead.

CAMILLUS, Marcus Furius, was the firſt who rendered the family of *Furius* illuſtrious. He triumphed four times, was five times dictator, and was honoured with the title of the *ſecond ſounder of Rome*. In a word, he acquired all the glory a man can gain in his own country. Lucius Apuleius, one of the tribunes, proſecuted him to make him give an account of the ſpoils taken at Veii. Camillus anticipated judgment, and baniſhed himſelf voluntarily. During his baniſhment, inſtead of rejoicing at the devaſtation of Rome by the Gauls, he exerted all his wiſdom and bravery to drive away the enemy; and yet kept with the utmoſt ſtrictneſs the ſacred law of Rome, in refuſing to accept the command, which ſeveral private perſons offered him. The Romans who were beſieged in the capitol, created him dictator in the year 363; in which office he acted with ſo much bravery and conduct, that he entirely drove the army of the Gauls out of the territories of the commonwealth. He died in the 81ſt year of his age, 365 years before the Chriſtian era.

CAMILLI and Camillæ, in *Antiquity*, boys and girls of ingenuous birth, who miniſtered in the ſacrifices of the gods; and eſpecially thoſe who attended the *flamen dialis*, or prieſt of Jupiter. The word ſeems borrowed from the language of the ancient Hetrurians, where it ſignified miniſter, and was changed from *caſmillus*. The Tuſcans alſo gave the appellation *Camillus* to Mercury, in quality of miniſter of the gods.

CAMINHA, a maritime town of Portugal, in the province of Entre-Duero-e-Minho, with the title of a duchy. It is ſituated at the mouth of the river Minho, in W. Long. 9. 15. N. Lat. 41. 44.

CAMIS, or Kamis, in the Japaneſe theology, denote deified ſouls of ancient heroes, who are ſuppoſed ſtill to intereſt themſelves in the welfare of the people whom they anciently commanded.

The camis anſwer to the heroes in the ancient Greek and Roman theology, and are venerated like the ſaints in the modern Roman church.

Beſides the heroes or camis beatified by the conſent of antiquity, the *mikaddos*, or pontiffs, have deified many others, and continue ſtill to grant the apotheoſis to new worthies; ſo that they ſwarm with *camis*: the principal one is *Tenſio Dai Sin*, the common father of Japan, to whom are paid devotions and pilgrimages extraordinary.

CAMISADE, in the art of war, an attack by ſurpriſe in the night, or at the break of day, when the enemy is ſuppoſed to be a-bed. The word is ſaid to have taken its riſe from an attack of this kind; wherein, as a badge or ſignal to know one another by, they bore a ſhift, in French called *chemiſe*, or *camiſe*, over their arms.

CAMISARDS, a name given by the French to the Calviniſts of the Cevennes, who formed a league, and took up arms in their own defence, in 1688.

CAMLETINE, a ſlight ſtuff, made of hair and coarſe ſilk, in the manner of camblet. It is now out of faſhion.

CAMMA, and Gobbi, two provinces of the kingdom of Loango in Africa. The inhabitants are continually at war with each other. The weapons they formerly uſed in their wars were the ſhort pike, bows and arrows, ſword and dagger; but ſince the Europeans have become acquainted with that coaſt, they have ſupplied them with fire-arms. The chief town of Gobbi lies about a day's journey from the ſea.—Their rivers abound with a variety of fiſh; but are infeſted with ſea-horſes, which do great miſchief both by land and water. The principal commerce with the natives is in logwood, elephants teeth and tails, the hair of which is highly valued, and uſed for ſeveral curious purpoſes.

CAMMIN, a maritime town of Germany, in Brandenburg Pomerania, ſituated in E. Long. 15°. N. Lat. 54°.

CAMOENS, Louis de, a famous Portugueſe poet, the honour of whoſe birth is claimed by different cities. But according to N. Antonio, and Manuel Correa, his intimate friend, this event happened at Liſbon in 1517. His family was of conſiderable note, and originally Spaniſh. In 1370, Vaſco Perez de Caamans, diſguſted at the court of Caſtile, fled to that of Liſbon, where King Ferdinand immediately admitted him into his council, and gave him the lordſhips of Sardoal, Punnete, Marano, Amendo, and other conſiderable lands; a certain proof of the eminence of his rank and abilities. In the war for the ſucceſſion, which broke out on the death of Ferdinand, Camoens ſided with the king of Caſtile, and was killed in the battle of Aljabarota. But though John I. the victor, ſeized a great part of his eſtate, his widow, the daughter of Gonſalo Tereyro, grand maſter of the order of Chriſt, and general of the Portugueſe army, was not reduced beneath her rank. She had three ſons who took the name of *Camoens*. The family of the eldeſt intermarried with the firſt nobility of Portugal; and even, according to Caſtera, with the blood royal. But the family of the ſecond brother, whoſe fortune was ſlender, had the ſuperior honour to produce the author of the Luſiad.

Early in his life the misfortunes of the poet began. In his infancy, Simon Vaz de Camoens, his father, commander of a veſſel, was ſhipwrecked at Goa, where, with his life, the greateſt part of his fortune was loſt. His mother, however, Anne de Macedo of Santarene, provided for the education of her ſon Louis at the univerſity of Coimbra. What he acquired there, his works diſcover; an intimacy with the claſſics, equal to that of a Scaliger, but directed by the taſte of a Milton or a Pope.

When he left the univerſity, he appeared at court. He was handſome; had ſpeaking eyes, it is ſaid; and the fineſt complexion. Certain it is, however, he was a poliſhed ſcholar, which, added to the natural ardour and gay vivacity of his diſpoſition, rendered him an accompliſhed gentleman. Courts are the ſcenes of intrigue; and intrigue was faſhionable at Liſbon. But the particulars of the amours of Camoens reſt unknown. This only appears: he had aſpired above his rank, for he was baniſhed from the court; and in ſeveral of his ſonnets he aſcribes this misfortune to love.

He now retired to his mother's friends at Santarene. Here he renewed his ſtudies, and began his poem on the diſcovery of India. John III. at this time prepared an armament againſt Africa. Camoens, tired of his inactive obſcure life, went to Ceuta in this expedition, and greatly diſtinguiſhed his valour in ſeveral rencounters. In a naval engagement with the Moors in the ſtraits of Gibraltar, in the conflict of boarding, he was among the foremoſt, and loſt his right eye. Yet neither hurry of actual ſervice nor the diſſipation of the camp could ſtifle his genius. He continued his *Luſiadas*, and ſeveral of his moſt beautiful ſonnets were written in Africa, while, as he expreſſed it,

> One hand the pen, and one the ſword, employ'd.

The fame of his valour had now reached the court, and he obtained permiſſion to return to Liſbon. But, while he ſolicited an eſtabliſhment which he had merited in the ranks of battle, the malignity of evil tongues, as he calls it in one of his letters, was injuriouſly poured upon him. Though the bloom of his early youth was effaced by ſeveral years reſidence under the ſcorching heavens of Africa, and though altered by the loſs of an eye, his preſence gave an uneaſineſs to the gentlemen of ſome families of the firſt rank where he had formerly viſited. Jealouſy is the characteriſtic of the Spaniards and Portugueſe; its reſentment knows no bounds, and Camoens now found it prudent to baniſh himſelf from his native country. Accordingly, in 1553, he ſailed for India, with a reſolution never to return. As the ſhip left the Tagus, he exclaimed, in the words of the ſepulchral monument of Scipio Africanus,

canus, *Ingrata patria, non poſſidebis oſſa mea!* "Ungrateful country, thou ſhalt not poſſeſs my bones!" But he knew not what evils in the eaſt would awake the remembrance of his native fields.

When Camoens arrived in India, an expedition was ready to ſail to revenge the king of Cochin on the king of Pimenta. Without any reſt on ſhore after his long voyage, he joined this armament, and in the conqueſt of the Alagada iſlands diſplayed his uſual bravery.

In the year following, he attended Manuel de Vaſconcello in an expedition to the Red ſea. Here, ſays Faria, as Camoens had no uſe for his ſword, he employed his pen. Nor was his activity confined to the fleet or camp. He viſited Mount Felix and the adjacent inhoſpitable regions of Africa, which he ſo ſtrongly pictures in the Luſiad, and in one of his little pieces where he laments the abſence of his miſtreſs.

When he returned to Goa, he enjoyed a tranquillity which enabled him to beſtow his attention on his epic poem. But this ſerenity was interrupted, perhaps by his own imprudence. He wrote ſome ſatires which gave offence: and by order of the viceroy Franciſco Barreto, he was baniſhed to China.

The accompliſhments and manners of Camoens ſoon found him friends, though under the diſgrace of baniſhment. He was appointed commiſſary of the defunct in the iſland of Macao, a Portugueſe ſettlement in the bay of Canton. Here he continued his Luſiad; and here alſo, after five years reſidence, he acquired a fortune, though ſmall, yet equal to his wiſhes. Don Conſtantine de Braganza was now viceroy of India; and Camoens, deſirous to return to Goa, reſigned his charge. In a ſhip, freighted by himſelf, he ſet ſail; but was ſhipwrecked in the gulf near the mouth of the river Mehon, on the coaſt of China. All he had acquired was loſt in the waves; his poems, which he held in one hand, while he ſwimmed with the other, were all he found himſelf poſſeſſed of when he ſtood friendleſs on the unknown ſhore. But the natives gave him a moſt humane reception: this he has immortalized in the prophetic ſong in the tenth Luſiad; and in the ſeventh, he tells us, that here he loſt the wealth which ſatisfied his wiſhes.

Agora da eſparança ja adquirida, &c.
Now bleſt with all the wealth fond hope could crave,
Soon I beheld that wealth beneath the wave
For ever loſt;———
My life, like Judah's heaven-doom'd king of yore,
By miracle prolong'd———

On the banks of the Mehon he wrote his beautiful paraphraſe of the pſalm, where the Jews, in the fineſt ſtrain of poetry, are repreſented as hanging their harps on the willows, by the rivers of Babylon, and weeping their exile from their native country. Here Camoens continued ſome time, till an opportunity offered to carry him to Goa. When he arrived at that city, Don Conſtantine de Braganza, the viceroy, whoſe characteriſtic was politeneſs, admitted him into intimate friendſhip, and Camoens was happy till Count Redondo aſſumed the government. Thoſe who had formerly procured the baniſhment of the ſatiriſt, were ſilent while Conſtantine was in power; but now they exerted all their arts againſt him. Redondo, when he entered on office, pretended to be the friend of Camoens; yet, with all that unfeeling indifference with which he made his moſt horrible witticiſm on the Zamorin, he ſuffered the innocent man to be thrown into the common priſon. After all the delay of bringing witneſſes, Camoens, in a public trial, fully refuted every accuſation of his conduct while commiſſary at Macao, and his enemies were loaded with ignominy and reproach. But Camoens had ſome creditors, and theſe detained him in priſon a conſiderable time, till the gentlemen of Goa began to be aſhamed that a man of his ſingular merit ſhould experience ſuch treatment among them. He was ſet at liberty; and again he aſſumed the profeſſion of arms, and received the allowance of a gentleman volunteer, a character at this time common in Portugueſe India. Soon after, Pedro Barreto, appointed governor of the fort at Sofala, by high promiſes, allured the poet to attend him thither. The governor of a diſtant fort, in a barbarous country, ſhares in ſome meaſure the fate of an exile. Yet, though the only motive of Barreto was, in this unpleaſant ſituation, to retain the converſation of Camoens at his table, it was his leaſt care to render the life of his gueſt agreeable. Chagrined with his treatment, and a conſiderable time having elapſed in vain dependence upon Barreto, Camoens reſolved to return to his native country. A ſhip, on the homeward voyage, at this time touched at Sofala, and ſeveral gentlemen who were on board, were deſirous that Camoens ſhould accompany them. But this the governor ungenerouſly endeavoured to prevent, and charged him with a debt for board. Anthony de Cabra, however, and Hector de Sylveyra, paid the demand; and Camoens, ſays Faria, and the honour of Barreto, were ſold together.

After an abſence of 16 years, Camoens, in 1569, returned to Liſbon, unhappy even in his arrival, for the peſtilence then raged in that city, and prevented his publication for three years. At laſt, in 1572, he printed his Luſiad, which, in the opening of the firſt book, in a moſt elegant turn of compliment, he addreſſed to his prince, King Sebaſtian, then in his 18th year. The king, ſays the French tranſlator, was ſo pleaſed with his merit, that he gave the author a penſion of 4000 reals, on condition that he ſhould reſide at court. But this ſalary, ſays the ſame writer, was withdrawn by Cardinal Henry, who ſucceeded to the crown of Portugal, loſt by Sebaſtian at the battle of Alcazar.

Though the great patron of one ſpecies of literature, a ſpecies the reverſe of that of Camoens, certain it is, that the author of the Luſiad was utterly neglected by Henry, under whoſe inglorious reign he died in all the miſery of poverty. By ſome, it is ſaid, he died in an alms-houſe. It appears, however, that he had not even the certainty of ſubſiſtence which theſe houſes provide. He had a black ſervant, who had grown old with him, and who had long experienced his maſter's humanity. This grateful Indian, a native of Java, who, according to ſome writers, ſaved his maſter's life in the unhappy ſhipwreck where he loſt his effects, begged in the ſtreets of Liſbon for the only man in Portugal on whom God had beſtowed theſe talents which have a tendency to erect the ſpirit of a downward age. To the eye of a careful obſerver, the fate of Camoens throws great light on that of his country, and will appear ſtrictly connected with it. The ſame ignorance, the ſame degenerated ſpirit, which ſuffered Camoens to depend on his ſhare of the alms begged in the ſtreets by his old hoary ſervant, the ſame ſpirit which cauſed this ſunk the kingdom of Portugal into the moſt abject vaſſalage ever experienced by a conquered nation. While the grandees of Portugal were blind to the ruin which impended over them, Camoens beheld it with a pungency of grief which haſtened his exit. In one of his letters he has theſe remarkable words: *Em fim accaberey à vida, e verram todos que fuy efeicoada a minho patria, &c.* "I am ending the courſe of my life; the world will witneſs how I have loved my country. I have returned, not only to die in her boſom, but to die with her."

In this unhappy ſituation, in 1579, in his 62d year, the year after the fatal defeat of Don Sebaſtian, died Louis de Camoens, the greateſt literary genius ever produced by Portugal; in martial courage and ſpirit of honour, nothing inferior to her greateſt heroes. And in a manner ſuitable to the poverty in which he died, was he buried.

CAMOMILE. See ANTHEMIS, BOTANY *Index*.

CAMP, the ground on which an army pitch their tents. It is marked out by the quartermaſter general, who appoints every regiment their ground.

The chief advantages to be minded in chooſing a camp for an army, are, to have it near the water, in a country of forage, where the ſoldiers may find wood for dreſſing their victuals; that it have a free communication with garriſons, and with a country from whence it may be ſupplied with proviſions; and, if poſſible, that it be ſituated on a riſing ground, in a dry gravelly ſoil. Beſides, the advantages of the ground ought to be conſidered, as marſhes, woods, rivers, and encloſures; and if the camp be near the enemy, with no river or marſh to cover it, the army ought to be intrenched. An army always encamps fronting the enemy; and generally in two lines, running parallel about 500 yards diſtance; the horſe and dragoons, on the wings; and the foot, in the centre: ſometimes a body of two, three, or four brigades, is encamped behind the two lines, and is called the *body of reſerve*. The artillery and bread-waggons are generally encamped in the rear of the two lines. A battalion of foot is allowed 80 or 100 paces for its camp; and 30 or 40 for an interval betwixt one battalion and another. A ſquadron of horſe is allowed 30 for its camp, and 30 for an interval, and more if the ground will allow it.

Where the grounds are equally dry, thoſe camps are always the moſt healthful that are pitched on the banks of large rivers; becauſe, in the hot ſeaſon, ſituations of this kind have a ſtream of freſh air from the water, ſerving to carry off the moiſt and putrid exhalations. On the other hand, next to marſhes, the worſt encampments are on low grounds cloſe beſet with trees; for then the air is not only moiſt and hurtful in itſelf, but by ſtagnating becomes more ſuſceptible of corruption. However, let the ſituation of camps be ever ſo good, they are frequently rendered infectious by the putrid effluvia of rotten ſtraw, and the privies of the army, more eſpecially if the bloody flux prevails; in which caſe the beſt method of preventing a general infection, is to leave the ground with the privies, foul ſtraw, and other filth, of the camp behind. This muſt be frequently done, if conſiſtent with the military operations: but when theſe render it improper to change the ground often, the privies ſhould be made deeper than uſual, and once a-day a thick layer of earth thrown into them till the pits are near full; and then they are to be well covered, and ſupplied by others. It may alſo be a proper caution to order the pits to be made either in the front or the rear, as the then ſtationary winds may beſt carry off their effluvia from the camp. Moreover, it will be neceſſary to change the ſtraw frequently, as being not only apt to rot, but to retain the infectious ſteams of the ſick. But if freſh ſtraw cannot be procured, more care muſt be taken in airing the tents, as well as the old ſtraw.

The diſpoſition of the Hebrew encampment was at firſt laid out by God himſelf. Their camp was of a quadrangular form, ſurrounded with an encloſure of the height of 10 hands-breadth. It made a ſquare of 12 miles in compaſs about the tabernacle; and within this was another called the *Levites camp*.

The Greeks had alſo their camps fortified with gates and ditches. The Lacedemonians made their camp of a round figure, looking upon that as the moſt perfect and defenſible of any form: we are not, however, to imagine, that they thought this form ſo eſſential to a camp, as never to be diſpenſed with when the circumſtances of the place required it. Of the reſt of the Grecian camps, it may be obſerved, that the moſt valiant of the ſoldiers were placed at the extremities, the reſt in the middle. Thus we learn from Homer, that Achilles and Ajax were poſted at the ends of the camp before Troy, as bulwarks on each ſide of the reſt of the princes.

The figure of the Roman camp was a ſquare divided into two principal parts: in the upper part were the general's pavilion, or prætorium, and the tents of the chief officers; in the lower, thoſe of inferior degree were placed. On one ſide of the prætorium ſtood the quæſtorium, or apartment of the treaſurer of the army: and near this the forum, both for a market place and the aſſembling of councils. On the other ſide of the prætorium were lodged the legati; and below it the tribunes had their quarters, oppoſite to their reſpective legions. Aſide of the tribunes were the præfecti of the foreign troops, over againſt their reſpective wings; and behind theſe were the lodgments of the evocati, then thoſe of the extraordinarii and ablecti equites, which concluded the higher part of the camp. Between the two partitions was a ſpot of ground called *principia*, for the altars and images of the gods, and probably alſo for the chief enſigns. The middle of the lower partition was aſſigned to the Roman horſe: next to them were quartered the triarii; then the principes, and cloſe by them the haſtati; afterwards the foreign horſe, and laſtly, the foreign foot. They fortified their camp with a ditch and parapet, which they termed *foſſa* and *vallum*; in the latter ſome diſtinguiſh two parts, viz. the *agger* or earth, and the *ſudes* or wooden ſtakes driven in to ſecure it. The camps were ſometimes ſurrounded by walls made of hewn ſtone; and the tents themſelves formed of the ſame matter.

In the front of the Turkiſh camp are quartered the janizaries and other foot, whoſe tents encompaſs their aga: in the rear are the quarters of the ſpahis and other horſemen. The body of the camp is poſſeſſed by the ſtately tents or pavilions of the vizier or general, rais effendi or chancellor, khaija, or ſteward, the teſterdar baſhaw or lord treaſurer, and kapiſlar kahiaſeer or maſter of the ceremonies. In the middle of theſe tents is a ſpacious field, wherein are erected a building for the divan, and a haſna or treaſury. When the ground is marked out for a camp, all wait for the pitching of the tent *lailac*, the place where the courts of juſtice are held; it being the diſpoſition of this that is to regulate all the reſt.

The Arabs ſtill live in camps, as the ancient Scenites did. The camp of the Aſſyne Emir, or king of the country about Tadmor, is deſcribed by a traveller who viewed it, as ſpread over a very large plain, and poſſeſſing ſo vaſt a ſpace, that though he had the advantage of a riſing ground, he could not ſee the utmoſt extent of it. His own tent was near the middle; ſcarce diſtinguiſhable from the reſt, except that it was bigger, being made, like the others, of a ſort of haircloth.

Camp, is alſo uſed by the Siameſe, and ſome other nations in the Eaſt Indies, as the name of the quarters which they aſſign to foreigners who come to trade with them. In theſe camps, every nation forms, as it were, a particular town, where they carry on all their trade, not only keeping all their warehouſes and ſhops there, but alſo live in theſe camps with their whole families. The Europeans, however, are ſo far indulged, that at Siam, and almoſt everywhere elſe, they may live either in the cities or ſuburbs, as they ſhall judge moſt convenient.

Camp-fight, or *Kamp-fight*, in law writers, denotes the trial of a cauſe by duel, or a legal combat of two champions in the field, for deciſion of ſome controverſy.

In the trial by camp-fight, the accuſer was, with the peril of his own body, to prove the accuſed guilty; and by offering him his glove, to challenge him to this trial, which the other muſt either accept of, or acknowledge himſelf guilty of the crime whereof he was accuſed.

If it were a crime deſerving death, the camp-fight was for life and death: if the offence deſerved only impriſonment, the camp-fight was accompliſhed when one combatant had ſubdued the other, ſo as either to make him yield or take him priſoner. The accuſed had liberty to chooſe another to fight in his ſtead, but the accuſer was obliged to perform it in his own perſon, and with equality of weapons. No women were permitted to be ſpectators, nor men under the age of thirteen. The prieſt and the people who looked on, were engaged ſilently in prayer, that the victory might fall to him who had right. None might cry, ſhriek, or give the leaſt ſign; which in ſome places was executed with ſo much ſtrictneſs, that the executioner ſtood ready with an axe to cut off the right hand or foot of the party that ſhould offend herein.

He that, being wounded, yielded himſelf, was at the other's mercy either to be killed or ſuffered to live. But if life were granted him, he was declared infamous by the judge, and diſabled from ever bearing arms, or riding on horſeback.

CAMPAGNA. See Campania.

CAMPAIGN, in the art of war, denotes the ſpace of time that an army keeps the field, or is encamped.— The beginning of every campaign is conſiderably more unhealthy than if the men were to remain in quarters. After the firſt fortnight or three weeks encampment, the ſickneſs decreaſes daily; the moſt infirm being by that time in the hoſpitals, and the weather daily growing warmer. This healthy ſtate continues throughout the ſummer, unleſs the men get wet clothes or wet beds; in which caſe, a greater or leſs degree of the dyſentery will appear in proportion to the preceding heats. But the moſt ſickly part of the campaign begins about the middle or end of Auguſt, whilſt the days are ſtill hot, but the nights cool and damp, with fogs and dews: then, and not ſooner, the dyſentery prevails; and though its violence is over by the beginning of October, yet the remitting fever gaining ground, continues throughout the reſt of the campaign, and never entirely ceaſes, even in winter-quarters, till the froſts begin. At the beginning of a campaign the ſickneſs is ſo uniform, that the number may be nearly predicted; but for the reſt of the ſeaſon, as the diſeaſes are then of a contagious nature, and depend ſo much upon the heats of ſummer, it is impoſſible to foreſee how many may fall ſick from the beginning to the end of autumn. It is alſo obſerved, that the laſt fortnight of a campaign, if protracted till the beginning of winter, is attended with more ſickneſs than the firſt two months encampment: ſo that it is better to take the field a fortnight ſooner, in order to return into winter-quarters ſo much the earlier. As to winter expeditions, though ſevere in appearance, they are attended with little ſickneſs, if the men have ſtrong ſhoes, quarters, fuel, and proviſions. Long marches in ſummer are not without danger, unleſs made in the night, or ſo early in the morning as to be over before the heat of the day.

CAMPANACEÆ, in Botany, an order of plants in the *Fragmenta methodi naturalis* of Linnæus, in which are the following genera, viz. convolvulus, ipomæa, polemonium, campanula, roella, viola, &c.*

CAMPANELLA, Thomas, a famous Italian philoſopher, born at Stilo in Calabria, in 1568. He diſtinguiſhed himſelf by his early proficiency in learning; for at the age of 13 he was a perfect maſter of the ancient orators and poets. His peculiar inclination was to philoſophy, to which he at laſt confined his whole time and ſtudy. In order to arrive at truth, he ſhook off the yoke of authority: by which means the novelty of ſome of his opinions expoſed him to many inconveniencies; for at Naples he was thrown into priſon, in which he remained 27 years, and during this confinement wrote his famous work entitled *Atheiſmus triumphatus*. Being at length ſet at liberty, he went to Paris, where he was graciouſly received by Louis XIII. and Cardinal Richelieu; the latter procured him a penſion of 2000 livres, and often conſulted him on the affairs of Italy. Campanella paſſed the remainder of his days in a monaſtery of Dominicans at Paris, and died in 1639.

CAMPANI, Matthew, of Spoletto, curate at Rome, wrote a curious treatiſe on the art of cutting glaſſes for ſpectacles, and made ſeveral improvements in optics, aſſiſted by his brother and pupil Joſeph. He died after 1678.

CAMPANIA, a town of Italy, in the kingdom of Naples,

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* See *Botany*, Natural Order.

Naples, and in the farther principato, with a biſhop's ſee. E. Long. 15. 30. N. Lat. 40. 40.

Campania, or *Compagna di Roma*, anciently Latium, a province of Italy, bounded on the weſt by the Tiber and the ſea, on the ſouth-weſt by the ſea, on the ſouth by Terra di Lavoro, on the eaſt by Abruzzo, and on the north by Sabina. Though the ſoil is good, it produces little or nothing, on account of the heavy duties on corn; and though the waters are good, the air is unwholeſome. It is ſubject to the Pope, and is about 60 miles in length on the Mediterranean ſea.

It has been generally thought that the air of this country hath ſomething in it peculiarly noxious during the ſummer-time; but Mr Condamine is of opinion that it is not more unhealthy than any other marſhy country. His account follows. "It was after the invaſion of the Goths in the fifth and ſixth centuries that this corruption of the air began to manifeſt itſelf. The bed of the Tiber being covered by the accumulated ruins of the edifices of ancient Rome, could not but raiſe itſelf conſiderably. But what permits us not to doubt of this fact is, that the ancient and well-preſerved pavement of the Pantheon and its portico is overflowed every winter; that the water even riſes there ſometimes to the height of eight or ten feet: and that it is not poſſible to ſuppoſe that the ancient Romans ſhould have built a temple in a place ſo low as to be covered with the waters of the Tiber on the leaſt inundation. It is evident, then, that the level of the bed of this river is raiſed ſeveral feet; which could not have happened without forming there a kind of dikes or bars. The choaking up of its canal neceſſarily occaſioned the overflow and reflux of its waters in ſuch places as till then had not been ſubject to inundations; to theſe overflowings of the Tiber were added all the waters that eſcaped out of the ancient aqueducts, the ruins of which are ſtill to be ſeen, and which were entirely broken and deſtroyed by Totila. What need, therefore, of any thing more to infect the air in a hot climate, than the exhalations of ſuch a maſs of ſtagnating waters deprived of any diſcharge, and become the receptacle of a thouſand impurities, as well as the grave of ſeveral millions both of men and animals? The evil could not but increaſe from the ſame cauſes while Rome was expoſed to the incurſions and devaſtations of the Lombards, the Normans, and the Saracens, which laſted for ſeveral centuries. The air was become ſo infectious there at the beginning of the 13th century, that Pope Innocent III. wrote, that few people at Rome arrived to the age of forty years, and that nothing was more uncommon there than to ſee a perſon of ſixty. A very ſhort time after, the popes transferred the ſeat of their reſidence to Avignon: during the ſeventy-two years they remained there, Rome became a deſert; the monaſteries in it were converted into ſtables; and Gregory XI. on his return to Rome, in 1376, hardly counted there 30,000 inhabitants. At his death began the troubles of the great ſchiſm in the weſt, which continued for upwards of 50 years. Martin V. in whom this ſchiſm ended in the year 1429, and his firſt ſucceſſors were able to make but feeble efforts againſt ſo inveterate an evil. It was not till the beginning of the 16th century that Leo X. under whom Rome began to reſume her wonted ſplendour, gave himſelf ſome trouble about re-eſtabliſhing the ſalubrity of the air: but the city, being ſhortly after beſieged twice ſucceſſively by the emperor Charles V. ſaw itſelf plunged again into all its old calamities; and from 85,000 inhabitants, which it contained under Leo X. it was reduced under Clement VIII. to 32,000. In ſhort, it is only ſince the time of Pius V. and Sextus V. at the end of the 16th century, that the popes have conſtantly employed the neceſſary methods for purifying the air of Rome and its environs, by procuring proper diſcharges for the waters, drying up the humid and marſhy grounds, and covering the banks of the Tiber and other places reputed uninhabitable with ſuperb edifices. Since that time a perſon may dwell at Rome, and go in or out of it at all ſeaſons of the year. At the beginning, however, of the preſent century, they were ſtill afraid to lie out of the city in ſummer, when they had reſided there; as they were alſo to return to it, when once they had quitted it. They never ventured to ſleep at Rome, even in broad day, in any other houſe than their own. They are greatly relaxed at preſent from theſe ancient ſcruples: I have ſeen cardinals, in the months of July and Auguſt, go from Rome to lie at Fraſcati, Tivoli, Albano, &c. and return the next or the following days to the city, without any detriment to their health: I have myſelf tried all theſe experiments, without ſuffering the leaſt inconvenience from them: we have even ſeen, in the laſt war in Italy, two armies encamped under the walls of Rome at the time when the heats were moſt violent. Yet, notwithſtanding all this, the greater part of the country people dare not ſtill venture to lie during that ſeaſon of the year, nor even as much as ſleep in a carriage, in any part of the territory comprehended under the name of the *Campagna of Rome*."

CAMPANIFORM, or Campanulated, an appellation given to flowers reſembling a bell.

CAMPANINI, a name given to an Italian marble dug out of the mountains of Carrara, becauſe, when it is worked, it ſounds like a bell.

CAMPANULA, or bell-flower. See Botany *Index*.

CAMPBELL, Archibald, earl and marquis of Argyle, was the ſon of Archibald earl of Argyle, by the lady Anne Douglas, daughter of William earl of Morton. He was born in the year 1598; and educated in the profeſſion of the Proteſtant religion, according to the ſtricteſt rules of the church of Scotland, as it was eſtabliſhed immediately after the reformation. During the commonwealth he was induced to ſubmit to its authority. Upon the reſtoration, he was tried for his compliance; a crime common to him with the whole nation, and ſuch a one as the moſt loyal and affectionate ſubject might frequently by violence be induced to commit. To make this compliance appear the more voluntary and hearty, there were produced in court letters which he had wrote to Albemarle, while that general governed Scotland, and which contained expreſſions of the moſt cordial attachment to the eſtabliſhed government. But, beſides the general indignation excited by Albemarle's diſcovery of this private correſpondence, men thought, that even the higheſt demonſtrations of affection might, during jealous times, be exacted as a neceſſary mark of compliance from a perſon of ſuch diſtinction as Argyle; and could not, by any equitable conſtruction, imply the crime of treaſon.

ſon. The parliament, however, ſcrupled not to paſs ſentence upon him, and he ſuffered with great conſtancy and courage.

Campbell, *Archibald*, earl of Argyle, ſon to the former, had from his youth diſtinguiſhed himſelf by his loyalty and his attachment to the royal family. Though his father was head of the covenanters, he himſelf refuſed to concur in any of their meaſures; and when a commiſſion of colonel was given him by the convention of ſtates, he forbore to act upon it till it ſhould be ratified by the king. By his reſpectful behaviour, as well as by his ſervices, he made himſelf acceptable to Charles when that prince was in Scotland, and even after the battle of Worceſter, all the misfortunes which attended the royal cauſe could not engage him to deſert it. Under Middleton he obſtinately perſevered to haraſs and infeſt the victorious Engliſh; and it was not till he received orders from that general, that he would ſubmit to accept of a capitulation. Such jealouſy of his loyal attachments was entertained by the commonwealth and protector, that a pretence was ſoon after fallen upon to commit him to priſon; and his confinement was rigorouſly continued till the reſtoration. The king, ſenſible of his ſervices, had remitted to him his father's forfeiture, and created him earl of Argyle; and when a moſt unjuſt ſentence was paſſed upon him by the Scots parliament, Charles had anew remitted it. In the ſubſequent part of this reign Argyle behaved himſelf dutifully; and though he ſeemed not diſpoſed to go all lengths with the court, he always appeared, even in his oppoſition, a man of mild diſpoſitions and peaceable deportment.

A parliament was ſummoned at Edinburgh in ſummer 1681, and the duke was appointed commiſſioner. Beſides granting money to the king, and voting the indefeaſible right of ſucceſſion, this parliament enacted a teſt, which all perſons poſſeſſed of offices, civil, military, or eccleſiaſtical, were bound to take. In this teſt the king's ſupremacy was aſſerted, the covenant renounced, paſſive obedience aſſented to, and all obligations diſclaimed of endeavouring any alteration in civil or eccleſiaſtical eſtabliſhments. This was the ſtate of the teſt as propoſed by the courtiers; but the country party propoſed alſo a clauſe of adherence to the Proteſtant religion, which could not with decency be rejected. The whole was of an enormous length, conſidered as an oath; and, what was worſe, a confeſſion of faith was there ratified which had been impoſed a little after the reformation, and which contained many articles altogether forged by the parliament and nation. Among others, the doctrine of reſiſtance was inculcated; ſo that the teſt being voted in a hurry, was found on examination to be a medley of abſurdity and contradiction. Though the courtiers could not reject the clauſe of adhereing to the Proteſtant religion, they propoſed, as a requiſite mark of reſpect, that all princes of the blood ſhould be exempted from taking that oath. This exception was zealouſly oppoſed by Argyle; who obſerved that the ſole danger to be dreaded for the Proteſtant religion muſt proceed from the perverſion of the royal family. By inſiſting on ſuch topics, he drew on himſelf the ſecret indignation of the duke of York, of which he ſoon felt the fatal conſequences.

When Argyle took the teſt as a privy counſellor, he ſubjoined, in the duke's preſence, an explanation which he had beforehand communicated to that prince, and which he believed to have been approved by him. It was in theſe words: "I have conſidered the teſt, and am very deſirous of giving obedience as far as I can. I am confident that the parliament never intended to impoſe contradictory oaths: therefore I think no man can explain it but for himſelf. Accordingly I take it as far as it is conſiſtent with itſelf and the Proteſtant religion. And I do declare that I mean not to bind myſelf, in my ſtation, and in a lawful way, from wiſhing and endeavouring any alteration, which I think to the advantage of church or ſtate, and not repugnant to the Proteſtant religion and my loyalty: and this I underſtand as a part of my oath." The duke, as was natural, heard it with great tranquillity: no one took the leaſt offence: Argyle was admitted to ſit that day in council: and it was impoſſible to imagine that a capital offence had been committed where occaſion ſeemed not to have been given ſo much as for a frown or reprimand.

Argyle was much ſurpriſed a few days after, to find that a warrant was iſſued for committing him to priſon; that he was indicted for high treaſon, leaſing-making, and perjury; and that from the innocent words abovementioned an accuſation was extracted, by which he was to forfeit life, honours, and fortune. It is needleſs to enter into particulars, where the iniquity of the whole is ſo evidently apparent. Though the ſword of juſtice was diſplayed, even her ſemblance was not put on; and the forms of law were preſerved to ſanctify, or rather aggravate, the oppreſſion. Of five judges, three did not ſcruple to find the guilt of treaſon and leaſing-making to be incurred by the priſoner: a jury of 15 noblemen gave verdict againſt him; and the king being conſulted, ordered the ſentence to be pronounced, but the execution of it to be ſuſpended till further orders. Argyle, however, ſaw no reaſon to truſt to the juſtice or mercy of ſuch enemies: He made his eſcape from priſon, and till he could find a ſhip for Holland he concealed himſelf during ſome time in London. The king heard of his lurking-place, but would not ſuffer him to be arreſted. All the parts, however, of his ſentence, ſo far as the government in Scotland had power, were rigorouſly executed; his eſtate confiſcated, his arms reverſed and torn. Having got over to Holland, he remained there during the remaining part of the reign of Charles II. But thinking himſelf at liberty, before the coronation of James II. to exert himſelf in order to recover the conſtitution by force of arms, he concerted meaſures with the Duke of Monmouth, and went into Scotland, to aſſemble his friends: but not meeting with the ſucceſs he expected, he was taken priſoner; and being carried to Edinburgh, was beheaded upon his former unjuſt ſentence, June 30. 1685. He ſhowed great conſtancy and courage under his misfortunes: on the day of his death he ate his dinner very cheerfully; and, according to cuſtom, ſlept after it a quarter of an hour or more, very ſoundly. At the place of execution, he made a ſhort, grave, and religious ſpeech; and, after ſolemnly declaring that he forgave all his enemies, ſubmitted to death with great firmneſs.

Campbell, *Archibald*, firſt duke of Argyle, ſon to the preceding, was an active promoter of the revolution. He came over with the prince of Orange; was admitted into the convention as earl of Argyle, though his father's attainder was not reverſed; and in the claim of rights the ſentence againſt him was declared to be, what moſt certainly it was, a reproach upon the nation. The eſtabliſhment of the crown upon the prince and princeſs of Orange being carried by a great majority in the Scotiſh convention, the earl was ſent from the nobility, with Sir James Montgomery and Sir John Dalrymple from the barons and boroughs, to offer the crown, in the name of the convention, to their majeſties, and tendered them the coronation oath; for which, and many other eminent ſervices, he was admitted a member of the privy council, and, in 1690, made one of the lords of the treaſury. He was afterwards made a colonel of the Scotch horſe guards; and, in 1694, one of the extraordinary lords of Seſſion. He was likewiſe created duke of Argyle, marquis of Kintyre and Lorn, earl of Campbell and Cowall, Viſcount of Lochow and Glenila, Lord Inverary, Mull, Morvern, and Terrey, by letters-patent, bearing date at Kenſington the 23d of June 1701. He ſent over a regiment to Flanders for King William's ſervice, the officers of which were chiefly of his own name and family, who bravely diſtinguiſhed themſelves through the whole courſe of the war. He married Elizabeth, daughter of Sir Lionel Talmaſh of Helmingham in the county of Suffolk, by Elizabeth ducheſs of Lauderdale his wife, daughter and heireſs of William Murray earl of Dyſart, by whom he left iſſue two ſons and a daughter; namely, John duke of Argyle, the ſubject of the next article; Archibald, who ſucceeded his brother as duke of Argyle; and Lady Anne, married to James Stuart, ſecond earl of Bute, by whom ſhe had a ſon afterwards earl of Bute.

CAMPBELL, *John*, ſecond duke of Argyle, and alſo duke of Greenwich and baron of Chatham, ſon to the ſubject of the preceding article, was born on the 10th of October 1680; and, on the very day when his grandfather ſuffered at Edinburgh, fell out of a window three pair of ſtairs high without receiving any hurt. At the age of 15, he had made a conſiderable progreſs in claſſical learning. His father then perceived and encouraged his military diſpoſition, and introduced him to King William, who appointed him to the command of a regiment. In this ſituation he remained till the death of his father in 1703; when becoming duke of Argyle, he was ſoon after ſworn of Queen Anne's privy council, made captain of the Scotch horſe guards, and appointed one of the extraordinary lords of ſeſſion. In 1704, her majeſty reviving the Scotiſh order of the thiſtle, his grace was inſtalled one of the knights of that order, and was ſoon after appointed high-commiſſioner to the Scotch parliament; where, being of great ſervice in promoting the intended union, he was on his return created a peer of England, by the titles of *baron of Chatham* and *earl of Greenwich*, and in 1710 was made knight of the garter. His grace firſt diſtinguiſhed himſelf in his military capacity at the battle of Oudenarde; where he commanded as brigadier-general, with all the bravery of youth and the conduct of a veteran officer. He was preſent under the duke of Marlborough at the ſiege of Ghent, and took poſſeſſion of the town. He had alſo a conſiderable ſhare in the victory obtained over the French at the battle of Malplaquet, by diſlodging them from the wood of Sart, and gaining a poſt of great conſequence. In this ſharp engagement, ſeveral muſket-balls paſſed through the duke's clothes, hat, and peruke. Soon after this hot action, he was ſent to take the command in Spain; and, after the reduction of Port Mahon, he returned to England. His grace having now a ſeat in the houſe of lords, he cenſured the meaſures of the miniſtry with ſuch freedom, that all his places were diſpoſed of to other noblemen: but at the acceſſion of George I. he recovered his influence. At the breaking out of the rebellion in 1715, he was made commander in chief of his majeſty's forces in North Britain; and was the principal means and cauſe of the total extinction, at that time, of the rebellion in Scotland, without much bloodſhed. In direct oppoſition to him, or that part of the army he commanded, at the head of all his Campbells was placed Campbell earl of Braidalbin, of the ſame family and kindred, by ſome fatal error that ever miſguided and miſled that unhappy family of the Stuarts and all its adherents. The conſequence was, that both ſets of Campbells, from family affection, refuſed to ſtrike a ſtroke, and retired out of the battle. He arrived at London March 6th 1716, and was in high favour: but, to the ſurpriſe of people of all ranks, he was in a few months diveſted of all his employments; and from this period to the year 1718, he ſignalized himſelf in a civil capacity, by his uncorrupted patriotiſm and manly eloquence. In the beginning of the year 1719, he was again admitted into favour, appointed lord-ſteward of the houſehold, and in April following was created duke of Greenwich. He continued in the adminiſtration during all the remaining part of that reign; and, after his late majeſty's acceſſion, till April 1740; when he delivered a ſpeech with ſuch warmth, that the miniſtry being highly offended, he was again diſmiſſed from his employments. To theſe, however, on the change of the miniſtry, he was ſoon reſtored; but not approving of the meaſures of the new miniſtry more than thoſe of the old, he gave up all his poſts for the laſt time, and never after engaged in affairs of ſtate. He now enjoyed privacy and retirement; and died of a paralytic diſorder on the 4th of October 1743. To the memory of his grace a very noble monument was erected in Weſtminſter-Abbey, executed by the ingenious Roubiliac.

The duke of Argyle, though never firſt miniſter, was a very able ſtateſman and politician, moſt ſteadily fixed in thoſe principles he believed to be right, and not to be ſhaken or changed. His delicacy and honour were ſo great, that it hurt him to be even ſuſpected; witneſs that application ſaid to be made to him by one of the adherents of the Stuart family before the laſt rebellion in order to gain his intereſt, which was conſiderable both in Scotland and England. He immediately ſent the letter to the ſecretary of ſtate; and it vexed him much even to have an application made him, leſt any perſon ſhould think him capable of acting a double part. When he thought meaſures wrong or corrupt, he cared not who was the author, however great or powerful he might be; witneſs his boldly attacking the great duke of Marlborough in the houſe of lords about his forage and army contracts in Flanders, in the very zenith of his power and popularity, though in all other reſpects he was the moſt able general of his time. The duke of Argyle on all occaſions ſpoke well, with a firm, manly, and noble eloquence; and ſeems to deſerve the character given of him by Pope:

> Argyle the ſtate's whole thunder born to wield,
> And ſhake alike the ſenate and the field.

In private life, the duke's conduct was highly exemplary. He was an affectionate huſband and an indulgent maſter. He ſeldom parted with his ſervants till age had rendered them incapable of their employments; and then he made proviſion for their ſubſiſtence. He was liberal to the poor, and particularly to perſons of merit in diſtreſs: but though he was ready to patronize deſerving perſons, he was extremely cautious not to deceive any by laviſh promiſes or leading them to form vain expectations. He was a ſtrict economiſt, and paid his tradeſmen punctually every month; and though he maintained the dignity of his rank, he took care that no part of his income ſhould be waſted in empty pomp or unneceſſary expences. He was twice married; and left five daughters, but no male iſſue. The titles of duke and earl of Greenwich and baron of Chatham became extinct at his death; but in his other titles he was ſucceeded by his brother Archibald earl of Ila, the ſubject of the next article.

CAMPBELL, *Archibald*, third duke of Argyle, brother to the ſubject of the preceding article, was born at Hamhouſe, in England, in June 1682, and was educated at the univerſity of Glaſgow. He afterwards applied himſelf to the ſtudy of the law at Utrecht; but, upon his father's being created a duke, he betook himſelf to a military life, and ſerved ſome time under the duke of Marlborough. Upon quitting the army, in which he did not long remain, he applied himſelf to the acquiſition of that knowledge which would enable him to make a figure in the political world. In 1705, he was conſtituted treaſurer of Scotland, and made a conſiderable figure in parliament, though he was not more than 23 years of age. In 1706, he was appointed one of the commiſſioners for treating of the Union; and the ſame year was created Lord Oronſay, Dunoon, and Arrois, Viſcount and Earl of Iſlay. In 1708, he was made an extraordinary lord of ſeſſion; and when the Union was effected, he was choſen one of the Sixteen Peers for Scotland, in the firſt parliament of Great Britain; and was conſtantly elected to every future parliament till his death, except the fourth. In 1710, he was made juſtice-general of Scotland. In 1711, he was called to the privy council; and upon the acceſſion of George I. he was nominated lord regiſter of Scotland. When the rebellion broke out in 1715, he again betook himſelf to arms, in defence of the houſe of Hanover, and by his prudent conduct in the Weſt Highlands, he prevented General Gordon at the head of three thouſand men, from penetrating into the country and raiſing levies. He afterwards joined his brother at Stirling, and was wounded at the battle of Dumblain. In 1725, he was appointed keeper of the privy ſeal; and from this time, he was entruſted with the management of Scotiſh affairs. In 1734, upon his reſigning the privy ſeal, he was made keeper of the great ſeal, which office he enjoyed till his death. Upon the deceaſe of his brother, he became duke of Argyle, hereditary juſtice-general, lieutenant, ſheriff, and commiſſary of Argyleſhire and the Weſtern Iſles, hereditary great maſter of the houſehold, hereditary keeper of Dunſtaffnage, Carrick, and ſeveral other caſtles. He was alſo chancellor of the univerſity of Aberdeen; and laboured to promote the intereſt of that, as well as of the other univerſities of Scotland. He particularly encouraged the ſchool of phyſic at Edinburgh, which has now acquired ſo high a reputation. Having the chief management of Scotch affairs, he was alſo extremely attentive to promote the trade, manufactures, and improvemens of his country. It was by his advice that, after the rebellion in 1745, the Highlanders were employed in the royal army. He was a man of great endowments both natural and acquired, well verſed in the laws of his country, and poſſeſſed conſiderable parliamentary abilities. He was likewiſe eminent for his ſkill in human nature, had great talents for converſation, and had collected one of the moſt valuable private libraries in Great Britain. He built himſelf a very magnificent ſeat at Inverary. The faculties of his mind continued ſound and vigorous till his death, which happened ſuddenly on the 15th of April 1761, in the 79th year of his age. He was married, but had no iſſue; and was ſucceeded in his titles and the eſtates of the family by John Campbell, fourth Duke of Argyle, ſon of the honourable John Camphell of Mammore, who was the ſecond ſon of Archibald the ninth earl of Argyle.

The family of Argyle was heritable juſtice generals for Scotland till aboliſhed by the juriſdiction act. They are ſtill heritable maſters of the king's houſehold in Scotland, and keepers of Dunſtaffnage and Carrick.

CAMPBELL, *John*, an eminent hiſtorical, biographical, and political writer, was born at Edinburgh, March 8. 1707-8. His father Robert Campbell of Glenlyon, Eſq; was captain of horſe in a regiment commanded by the then earl of Hyndford; and his mother, Elizabeth, daughter of —— Smith, Eſq; of Windſor in Berkſhire, had the honour of claiming a deſcent from the poet Waller. Our author, their fourth ſon, was at the age of five years carried from Scotland to Windſor, where he received the firſt principles of his education; and at a proper age, he was placed out as clerk to an attorney, being intended for the law. This profeſſion, however, he never followed; but by a cloſe application to the acquiſition of knowledge of various kinds, became qualified to appear with great advantage in the literary world. In 1736, before he had completed his 30th year, he gave to the public, in two volumes folio, "The Military Hiſtory of Prince Eugene and the duke of Marlborough," enriched with maps, plans, and cuts. The reputation hence acquired, occaſioned him ſoon after to be ſolicited to take a part in the "Ancient Univerſal Hiſtory." Whilſt employed in this capital work, Mr Campbell found leiſure to entertain the world with other productions. In 1739, he publiſhed the "Travels and Adventures of Edward Brown, Eſq;" 8vo. In the ſame year appeared his "Memoirs of the Baſhaw Duke de Ripperda," 8vo, reprinted, with improvements, in 1740. Theſe memoirs were followed, in 1741, by the “Conciſe Hiſtory of Spaniſh America,” 8vo. In 1742, he was the author of “A Letter to a Friend in the Country, on the Publication of Thurloe's State Papers; giving an account of their diſcovery, importance, and utility. The ſame year was diſtinguiſhed by the appearance of the 1ſt and 2d volumes of his “Lives of the Engliſh Admirals, and other eminent Britiſh Seamen.” The two remaining volumes were completed in 1744; and the whole, not long after, was tranſlated into German. This was the firſt of Mr Campbell's works, to which he prefixed his name; and it is a performance of great and acknowledged merit. In 1743, he publiſhed “Hermippus revived;” a ſecond edition of which, much improved and enlarged, came out in 1749, under the following title: “Hermippus Redivivus: or, the Sage's Triumph over Old Age and the Grave” Wherein a method is laid down for prolonging the life and vigour of man. Including a Commentary upon an ancient Inſcription, in which this great ſecret is revealed; ſupported by numerous authorities. The whole interſperſed with a great variety of remarkable and well-atteſted relations.” This extraordinary tract had its origin in a foreign publication; but it was wrought up to perfection by the additional ingenuity and learning of Mr Campbell. In 1744 he gave to the public, in two volumes folio, his “Voyages and Travels,” on Dr Harris's plan, being a very diſtinguiſhed improvement of that collection which had appeared in 1705. The time and care employed by Mr Campbell in this important undertaking did not prevent his engaging in another great work, the “Biographia Britannica,” which began to be publiſhed in weekly numbers in 1745, and extended to ſeven volumes folio: but our author's articles were only in the firſt four volumes; of which Dr Kippis obſerves, they conſtitute the prime merit.

When the late Mr Dodſley formed the deſign of “The Preceptor,” which appeared in 1748, Mr Campbell was to aſſiſt in the undertaking; and the parts written by him were the Introduction to Chronology, and the Diſcourſe on Trade and Commerce, both of which diſplayed an extenſive fund of knowledge upon theſe ſubjects. In 1750 he publiſhed the firſt ſeparate edition of his “Preſent State of Europe;” a work which had been originally begun in 1746, in the “Muſeum,” a very valuable periodical performance, printed for Dodſley. There is no production of our author's that hath met with a better reception. It has gone through ſix editions, and fully deſerved this encouragement. The next great undertaking which called for the exertion of our author's abilities and learning, was “The modern Univerſal Hiſtory.” This extenſive work was publiſhed, from time to time, in detached parts, till it amounted to 16 volumes folio; and a ſecond edition of it, in 8vo. began to make its appearance in 1759. The parts of it written by Mr Campbell were, the hiſtories of the Portugueſe, Dutch, Spaniſh, French, Swediſh, Daniſh, and Oſtend ſettlements in the Eaſt Indies; and the Hiſtories of the Kingdoms of Spain, Portugal, Algarve, Navarre, and that of France, from Clovis to 1656. As our author had thus diſtinguiſhed himſelf in the literary world, the degree of LL. D. was very properly and honourably conferred upon him, June 18. 1754, by the univerſity of Glaſgow.

His principal and favourite work was, “A political Survey of Great Britain,” 2 vols. 4to, publiſhed a ſhort time before his death; in which the extent of his knowledge, and his patriotic ſpirit, are equally conſpicuous. Dr Campbell's reputation was not confined to his own country, but extended to the remoteſt parts of Europe. As a ſtriking inſtance of this, it may be mentioned, that in the ſpring of 1774, the empreſs of Ruſſia was pleaſed to honour him with the preſent of her picture, drawn in the robes worn in that country in the days of John Baſiliowitz, grand duke of Muſcovy, who was contemporary with Queen Elizabeth. To manifeſt the doctor's ſenſe of her imperial majeſty's goodneſs, a ſet of the “Political Survey of Britain,” bound in Morocco, highly ornamented, and accompanied with a letter deſcriptivie of the triumphs and felicities of her reign, was forwarded to St Peterſburg, and conveyed into her hands by Prince Orloff, who had reſided ſome months in this kingdom.

Dr Campbell in 1736 married Elizabeth, daughter of Benjamin Vobe, of Leominſter, in the county of Hereford, gentlemen, with whom he lived nearly 40 years in the greateſt conjugal harmony and happineſs. So wholly did he dedicate his time to books, that he ſeldom went abroad: but to relieve himſelf as much as poſſible from the inconveniences incident to a ſedentary life, it was his cuſtom, when the weather would admit, to walk in his garden; or otherwiſe in ſome room of his houſe, by way of exerciſe. By this method, united with the ſtricteſt temperance in eating, and an equal abſtemiouſneſs in drinking, he enjoyed a good ſtate of health, though his conſtitution was delicate. His domeſtic manner of living did not preclude him from a very extenſive and honourable acquaintance. His houſe, eſpecially on a Sunday evening, was the reſort of the moſt diſtinguiſhed perſons of all ranks, and particularly of ſuch as had rendered themſelves eminent by their knowledge or love of literature. He received foreigners, who were fond of learning, with an affability and kindneſs which excited in them the higheſt reſpect and veneration; and his inſtructive and cheerful converſation made him the delight of his friends in general. He was, during the latter part of his life, agent for the province of Georgia in North America; and died at the cloſe of the year 1775, in the 67th year of his age. The doctor's literary knowledge was by no means confined to the ſubjects on which he more particularly treated as an author; he was well acquainted with the mathematics, and had read much in medicine. It hath been with great reaſon believed, that if he had dedicated his ſtudies to this laſt ſcience, he would have made a very conſpicuous figure in the medical profeſſion. He was eminently verſed in the different parts of ſacred literature; and his acquaintance with the languages extended not only to the Hebrew, Greek and Latin among the ancient, and to the French, Italian, Spaniſh, Portugueſe, and Dutch, among the modern; but likewiſe to the Oriental tongues. He was particularly fond of the Greek language. His attainment of ſuch a variety of knowledge was exceedingly aſſiſted by a memory ſurpriſingly retentive, and which indeed aſtoniſhed every perſon with whom he was converſant. In communicating his ideas, he had an uncommon readineſs and facility; and the ſtyle of his works, which had been formed upon the model of that of the celebrated Biſhop Sprat, was perſpicuous, eaſy, flowing, and harmonious. To all theſe accompliſhments of the underſtanding, Dr Campbell joined the more important virtues of a moral and pious character. His diſpoſition was gentle and humane, and his manners kind and obliging. He was the tendereſt of huſbands, a moſt indulgent parent, a kind maſter, a firm and ſincere friend. To his great Creator he paid the conſtant and ardent tribute of devotion, duty, and reverence; and in his correſpondences he ſhowed that a ſenſe of piety was always neareſt his heart.

Campbell, *George*, D. D. was born at Aberdeen in December 1719. He was educated at the grammar ſchool in the ſame town, and intended for the employment of ſignet-writer, an occupation ſimilar to that of an Engliſh attorney, in which he was bound an apprentice. The love of ſtudy, however, prevailed over every oppoſition: in 1741 he attended divinity lectures at Edinburgh before the term of his apprenticeſhip was fully completed, and ſoon after became a regular ſtudent in the univerſity of Aberdeen, attending the lectures of Profeſſor Lumſden in King's, and Profeſſor Chalmers in Mariſchal, college. In 1746 he was licenſed to preach by the preſbytery of Aberdeen. In 1748 he obtained the living of Banchory Ternan, in which ſituation he became a married man, and was fortunate in poſſeſſing a lady "remarkable for the ſagacity of her underſtanding, the integrity of her heart, the general propriety of her conduct, and her ſkill in the management of domeſtic œconomy." Mutual happineſs was the conſequence of this union, which was not terminated till her death in 1792. In 1757 he was tranſlated to Aberdeen, to be one of the miniſters of that town, and in 1759 was preſented to the office of principal of Mariſchal college.

Mr Hume's Treatiſe on Miracles gave the new principal an opportunity of evincing that he was not unworthy of his office. He oppoſed it in a ſermon preached before the provincial ſynod of Aberdeen, in 1760, which he was requeſted to publiſh; but he preferred the form of a diſſertation, and in that ſtate ſent the manuſcript to Dr Blair, to be by him communicated to the metaphyſician. Availing himſelf then of the remarks of his friends, and his opponent, he gave it to the world in 1763, with a dedication to Lord Bute: but however deſirable the patronage of the miniſter might be in other reſpects, it was of very little aſſiſtance in giving circulation, in the literary world, to an eſſay which, from the favourable impreſſions of Blair and Hume, was eagerly read, and univerſally admired.

In 1771 he was elected profeſſor of divinity in Mariſchal college, on which he reſigned his office as one of the miniſters of Aberdeen: but as "miniſter of Gray Friars, an office conjoined to the profeſſorſhip about a century ago, he was obliged to preach once every Sunday in one of the eſtabliſhed churches." Few perſons ſeem to have entertained truer notions of the office of a teacher in an univerſity than our new profeſſor; and the plan he had in view, on entering upon his lectures, though expreſſed in rather too ſtrong language, may be recommended to every one who undertakes a ſimilar employment.

"Gentlemen, (he thus addreſſes his pupils) the nature of my office has been much miſunderſtood. It is ſuppoſed, that I am to teach you every thing connected with the ſtudy of divinity. I tell you honeſtly, that I am to teach you nothing. Ye are not ſchool-boys. Ye are young men, who have finiſhed your courſes of philoſophy, and ye are no longer to be treated as if ye were at ſchool. Therefore, I repeat it, I am to teach you nothing; but, by the grace of God, I will aſſiſt you to teach yourſelves every thing." In 1771 he publiſhed his excellent ſermon on the Spirit of the Goſpel; and, in 1776, his Philoſophy of Rhetoric. In this latter year, alſo, he acquired the friendſhip of Dr Tucker by a ſermon, then much admired, and very generally read, on the Duty of Allegiance, in which he endeavours to ſhow "that the Britiſh colonies in America had no right either from reaſon or from ſcripture, to throw off their allegiance;" and he uſes thoſe vulgar arguments, which, as being purely political, and more eſpecially adapted to the ſentiments of the majority of that day, were very improper topics for the pulpit. It is ſo much the faſhion for divines to make the varying politics of the hour the ſubject of their diſcourſes, and in them to follow the ſentiments of thoſe whoſe patronage is deemed moſt advantageous, that we muſt not be very ſevere in our animadverſions on the preſent occaſion. In 1777 he choſe a better ſubject for a diſcourſe, which he publiſhed at the requeſt of the Society for propagating Chriſtian Knowledge, and in which the ſucceſs of the firſt publiſhers of the Goſpel is ably treated as a proof of its truth. In 1779, when many of his countrymen, led away by the madneſs of enthuſiaſm and fanaticiſm, were ruſhing headlong into the moſt antichriſtian practice of perſecution, he publiſhed a very ſeaſonable addreſs to the people of Scotland, on the alarms which had been raiſed by the bill in favour of the Roman Catholics.

In the ſame year, alſo, he publiſhed a ſermon on the Happy Influence of Religion on Civil Society. The laſt work which he lived to bring before the public was his Tranſlation of the Four Goſpels, with preliminary diſſertations, and explanatory notes, of which it is unneceſſary to ſay any thing farther in this place than that it is worthy of his talents and character.

In 1795 he reſigned his profeſſorſhip, in a letter to the moderator of the preſbytery of Aberdeen, which they voted to be inſerted in their records. Soon after the reſignation of his profeſſorſhip, he reſigned alſo the principalſhip, on a penſion of 300l. a-year being conferred on him by government; but this penſion he poſſeſſed for a very ſhort time, for, on the 31ſt of March, 1796, his laſt illneſs ſeized him, and on the next morning it was followed by a paroxyſm of the palſy, which deſtroyed his faculty of ſpeech, and under which he languiſhed till he died. His funeral ſermon was preached on the 17th of April by Dr Brown, who had ſucceeded him in the offices of principal and profeſſor.

His character, very juſtly drawn by the ſame gentleman, we ſhall now lay before our readers. "Dr Campbell, as a public teacher, was long admired for the clearneſs and copiouſneſs with which he illuſtrated the great doctrines and precepts of religion, and the ſtrength and energy with which he enforced them. Intimately perſuaded of the truth and infinite conſequence of what revelation teaches, he was ſtrongly deſirous of carying the ſame conviction to the minds of his hearers, and delivered his diſcourſes with that zeal which flows from ſtrong impreſſions, and that power of perſuaſion which is the reſult of ſincerity of heart, combined with clearneſs of underſtanding. He was ſatisfied, that the more the pure dictates of the goſpel were ſtudied, the more they would approve themſelves to the mind, and bring forth, in the affections and conduct, all the peaceable fruits of righteouſneſs. The unadulterated dictates of Chriſtianity, he was, therefore, only ſtudious to recommend and inculcate; and knew perfectly to diſcriminate them from the inventions and traditions of men. His chief ſtudy ever was, to direct belief to the great objects of practice; and, without theſe, he viewed the moſt orthodox profeſſion as "a ſounding braſs, and a tinkling cymbal." But, beſides the character of a preacher of righteouſneſs, he had alſo that of a teacher of the ſcience of divinity to ſuſtain. How admirably he diſcharged this duty, and with what effect he conveyed the ſoundeſt and moſt profitable inſtruction to the minds of his ſcholars, let thoſe declare who are now in various congregations of this country, communicating to their fellow Chriſtians the fruits of their ſtudies under ſo able and judicious a teacher. Diſcarding all attachment to human ſyſtems, merely conſidered as ſuch, he tied his faith to the Word of God alone, poſſeſſed the happieſt talent in inveſtigating its meaning, and communicated to his hearers the reſult of his own inquiries, with a preciſion and perſpicuity which brought light out of obſcurity, and rendered clear and ſimple what appeared intricate and perplexed. He expoſed, without reſerve, the corruptions which ignorance, craft, and hypocriſy, had introduced into religion, and applied his talent for ridicule to the beſt of all purpoſes, to hold up to contempt the abſurdities with which the pureſt and ſublimeſt truths had been loaded.

"Placed at the head of a public ſeminary of learning, he felt all the importance of ſuch a ſituation, and uniformly directed his influence to public utility. His enlarged and enlightened mind juſtly appreciated the extenſive conſequence of the education of youth. He anticipated all the effects reſulting to the great community of mankind, from numbers of young men iſſuing, in regular ſucceſſion, from the univerſity over which he preſided, and occupying the different departments of ſocial life.

"His benevolent heart delighted to repreſent to itſelf the ſtudents under his direction uſefully and honourably diſcharging the reſpective duties of their different profeſſions; and ſome of them, perhaps, filling the moſt diſtinguiſhed ſtations of civil ſociety. With theſe proſpects before him, he conſtantly directed his public conduct to their attainment. He never ſuffered his judgment to be warped by prejudice or partiality, or his heart to be ſeduced by paſſion or private intereſt. Thoſe mean and ignoble motives by which many are actuated in the diſcharge of important truſts, approached not his mind. A certain honourable pride, if pride it may be called, diffuſed an uniform dignity over the whole of his behaviour. He felt the man degraded by the perverſion of public character. His underſtanding alſo clearly ſhewed him even perſonal advantage attached to ſuch principles and practice, as he adopted from a ſenſe of obligation, and thoſe elevated conceptions of real worth which were ſo congenial to his ſoul. He ſaw, he experienced, eſteem, reſpect, and influence, following in the train of integrity and beneficence; but contempt, diſgrace, averſion, and complete inſignificance, cloſely linked to corruption and ſelfiſhneſs. Little minds are ſeduced and overpowered by ſelfiſh conſiderations, becauſe they have not the capacity to look beyond the preſent advantage, and to extend to the miſery that ſtands on the other ſide of it. The ſame circumſtance that betrays the perverſity of their hearts, alſo evinces the weakneſs of their judgments.

"His reputation as a writer is as extenſive as the preſent intercourſe of letters; not confined to his own country, but ſpread through every civilized nation. In his literary purſuits, he aimed not, as is very often the caſe, with men of diſtinguiſhed literary abilities, merely at eſtabliſhing his own celebrity, or increaſing his fortune; but had chiefly at heart the defence of the great cauſe of Religion, or the elucidation of her dictates.

"At an early period he entered the liſts as a champion for Chriſtianity againſt one of its acuteſt opponents. He not only triumphantly refuted his arguments, but even conciliated his reſpect by the handſome and dexterous manner in which his defence was conducted. While he refuted the infidel, he ſpared the man, and exhibited the uncommon ſpectacle of a polemical writer poſſeſſing all the moderation of a Chriſtian. But while he defended Chriſtianity againſt its enemies, he was deſirous of contributing his endeavours to increaſe, among its profeſſors, the knowledge of the ſacred writings. Accordingly, in the latter part of his life, he favoured the world with a work, the fruit of copious erudition, of unwearied application for almoſt thirty years, and of a clear and comprehenſive judgment. We have only to regret, that the other writings of the New Teſtament have not been elucidated by the ſame pen that tranſlated the Goſpels. Nor were his literary merits confined to theology, and the ſtudies more immediately connected with it. Philoſophy, and the fine arts, are alſo indebted to his genius and labours; and in him the polite ſcholar was eminently joined to the deep and liberal divine.

"Political principles will always be much affected by general character. This was alſo the caſe with Dr Campbell. In politics, he maintained that moderation which is the ſureſt criterion of truth and rectitude, and was equally diſtant from thoſe extremes into which men are ſo apt to run in great political queſtions. He cheriſhed that patriotiſm which conſiſts in wiſhing, and endeavouring to promote the greateſt happineſs of his country, and is always ſubordinate to univerſal benevolence. Firmly attached to the Britiſh conſtitution, he was animated with that genuine love of liberty which it inſpires and invigorates. He was equally averſe to deſpotiſm and to popular anarchy; the two evils into which political parties are ſo frequently hurried, to the deſtruction of all that is valuable to government. Party-ſpirit, of whatever deſcription, he conſidered as having an unhappy tendency to pervert, to the moſt pernicious purpoſes, the beſt principles of the human mind, and to clothe the moſt iniquitous actions with the moſt ſpecious appearances. Although tenacious of thoſe ſentiments, whether in religion or politics, which he was convinced to be rational and juſt, he never ſuffered mere difference of opinion to impair his good will, to obſtruct his good offices, or to cloud the cheerfulneſs of converſation. His own converſation was enlivened by a vein of the moſt agreeable pleaſantry."

CAMPBELTOWN, a parliament town of Argyleſhire in Scotland, ſeated on the eaſtern ſhore of the peninſula of Kintyre or Cantyre, of which it is the capital. It hath a good harbour; and is now a very conſiderable place, though within theſe 50 years only a petty fiſhing town. It has in fact been created by the fiſhery: for it was appointed the place of rendezvous for the buſſes; and above 260 have been ſeen in the harbour at once. The inhabitants are reckoned at upwards of 8000 in number. W. Long. 5. 10. N. Lat. 54.

CAMPDEN, a ſmall town of Glouceſterſhire in England, containing about 200 houſes. It gives title of Viſcount, by courteſy, to the earl of Gainſborough his ſon. W. Long. 1. 50. N. Lat. 52.

CAMPEACHY, a town of Mexico in South America, ſeated on the eaſt coaſt of a bay of the ſame name, on the weſt of the province of Yucataro. It is defended by a good wall and ſtrong forts; but is neither ſo rich, nor carries on ſuch a trade, as formerly; it having been the port for the ſale of logwood, the place where it is cut being about 30 miles diſtant. It was taken by the Engliſh in 1596; by the bucaneers in 1678; and by the Flibuſters of St Domingo in 1685, who ſet it on fire and blew up the citadel. W. Long. 93. 7. N. Lat. 19. 20.

Campeachy-Wood. See HÆMATOXYLUM, BOTANY *Index*.

CAMPEN, a ſtrong town of Overyſſel in the United Provinces. It hath a citadel and a harbour; but the latter is almoſt choked up with ſand. It was taken by the Dutch in 1578, and by the French in 1672: but they abandoned it the following year. It is ſeated near the mouth of the river Yſſel and Zuider Zee. E. Long. 5. 35. N. Lat. 52. 38.

CAMPESTRE, in antiquity, a ſort of cover for the privities, worn by the Roman ſoldiers in their field exerciſes; being girt under the naval, and hanging down to the knees. The name is ſuppoſed to be formed from *campus*, the field or place where the Roman ſoldiers performed their exerciſes.

CAMPHORA, or CAMPHIRE, a ſolid concrete ſubſtance extracted from the wood of the laurus camphora. See CHEMISTRY, and MATERIA MEDICA *Index*.

Pure camphire is very white, pellucid, ſomewhat unctuous to the touch; of a bitteriſh aromatic taſte, yet accompanied with a ſenſe of coolneſs; of a very fragrant ſmell, ſomewhat like that of roſemary, but much ſtronger. It has been very long eſteemed one of the moſt efficacious diaphoretics; and has been celebrated in fevers, malignant and epidemical diſtempers. In deliria, alſo, were opiates could not procure ſleep, but rather aggravated the ſymptoms, this medicine has often been obſerved to procure it. All theſe effects, however, Dr Cullen attributes to its ſedative property, and denies that camphire has any other medicinal virtues than thoſe of an antiſpaſmodic and ſedative. He allows it to be very powerful, and capable of doing much good or much harm. From experiments made on different brute creatures, camphire appears to be poiſonous to every one of them. In ſome it produced ſleep followed by death, without any other ſymptom. In others, before death, they were awakened into convulſions and rage. It ſeems, too, to act chiefly on the ſtomach; for an entire piece ſwallowed, produced the above-mentioned effects with very little diminution of weight.

CAMPHUYSEN, DIRK THEODORE RAPHAEL, an eminent painter, was born at Gorcum in 1586. He learned the art of painting from Diederic Govertze; and by a ſtudious application to it, he very ſoon not only equalled, but far ſurpaſſed his maſter. He had an uncommon genius, and ſtudied nature with care, judgment, and aſſiduity. His ſubjects were landſcapes, moſtly ſmall, with ruinous buildings, huts of peaſants or views of villages on the banks of rivers, with boats and hoys, and generally he repreſented them by moonlight. His pencil is remarkably tender and ſoft, his colouring true nature and very tranſparent, and his expertneſs in perſpective is ſeen in the proportional diſtances of his objects, which are excellently contrived, and have a ſurpriſing degree of nature and truth. As he left off painting at an age when others are ſcarcely qualified to commence artiſts, few of his works are to be met with, and they bring conſiderable prices; as they cannot but give pleaſure to the eye of every obſerver. He painted his pictures with a thin body of colour, but they are handled with ſingular neatneſs and ſpirit. He practiſed in his profeſſion only till he was 18 years of age, and being then recommended as a tutor to the ſons of the lord of Nieuport, he undertook the employment, and diſcharged it with ſo much credit, that he was appointed ſecretary to that nobleman. He excelled in drawing with a pen; and the deſigns which he finiſhed in that manner are exceedingly valued.

CAMPIAN, EDMUND, an Engliſh Jeſuit, was born at London, of indigent parents, in the year 1540; and educated at Chriſt's hoſpital, where he had the honour to ſpeak an oration before Queen Mary on her acceſſion to the throne. He was admitted a ſcholar of St John's college in Oxford at its foundation, and took the degree of maſter of arts in 1564. About the ſame time he was ordained by a biſhop of the church of England, and became an eloquent Proteſtant preacher. In 1566, when Queen Elizabeth was entertained by the univerſity of Oxford, he ſpoke an elegant oration before her majeſty, and was alſo reſpondent in the philoſophy act in St Mary's church. In 1568, he was junior proctor of the univerſity. In the following year, he went over to Ireland, where he wrote a hiſtory of that kingdom, and turned papiſt; but being found rather too aſſiduous in perſuading others to follow his example, he was committed to priſon. He ſoon, however, found means to make his eſcape. He landed in England in 1571; and thence proceeded to Douay in Flanders, where he publicly recanted his former hereſy, and was created bachelor of divinity. He went ſoon after to Rome, where, in 1573, he was admitted of the ſociety of Jeſus, and was ſent by the general of that order to Vienna, where he wrote his tragedy called

led *Neſtor et ambroſia*, which was acted before the emperor with great applauſe.

From Vienna he went to Prague in Bohemia, where he reſided in the Jeſuits college about ſix years, and then returned to Rome. From thence, in 1580, he was ſent by Pope Gregory XIII. with the celebrated Father Parſons, to convert the people of England. From Pitts we learn, that, ſome time before, ſeveral Engliſh prieſts, inſpired by the Holy Ghoſt, had undertaken to convert their countrymen; that 80 of theſe foreign ſeminaries, beſides ſeveral others who by God's grace had been converted in England, were actually engaged in the pious work with great ſucceſs; that ſome of them had ſuffered impriſonment, chains, tortures, and ignominious death, with becoming conſtancy and reſolution: but ſeeing at laſt that the labour was abundant and the labourers few, they ſolicited the aſſiſtance of the Jeſuits; requeſting, that though not early in the morning, they would at leaſt in the third, ſixth, or ninth hour, ſend labourers into the Lord's vineyard. In conſequence of this ſolicitation, the above two were ſent to England. They arrived in an evil hour for Campian, at Dover; and were next day joyfully received by their friends at London. He had not been long in England, before Walſingham the ſecretary of ſtate, being informed of his uncommon aſſiduity in the cauſe of the church of Rome, uſed every means in his power to have him apprehended, but for a long time without ſucceſs. However, he was at laſt taken by one Elliot, a noted *prieſt-taker*, who found him in the houſe of Edward Yates, Eſq; at Lyford in Berkſhire, and conducted him in triumph to London, with a paper on his hat, on which was written *Campian the Jeſuit*. He was impriſoned in the Tower; where Wood ſays, "he did undergo many examinations, abuſes, wrackings, tortures;" *exquiſitiſſimis cruciatibus tortus*, ſays Pitts. It is hoped, for the credit of our reformers, this torturing part of the ſtory is not true. The poor wretch, however, was condemned, on the ſtatute 25 Ed. III. for high treaſon; and butchered at Tyburn, with two or three of his fraternity. Howſoever criminal in the eye of the law, or of the Engliſh goſpel, might be the zeal of this Jeſuit for the ſalvation of the poor heretics of this kingdom, biographers of each perſuaſion unite in giving him a great and amiable character. "All writers (ſays the Oxford antiquary), whether Proteſtants or Popiſh, ſay, that he was a man of admirable parts; an elegant orator, a ſubtile philoſopher and diſputant, and an exact preacher whether in Engliſh or the Latin tongue, of a ſweet diſpoſition, and a well-poliſhed man." Fuller, in his church-hiſtory, ſays, "he was of a ſweet nature, conſtantly carrying about him the charms of a plauſible behaviour, of a fluent tongue, and good parts." His Hiſtory of Ireland, in two books, was written in 1570; and publiſhed, by Sir James Ware, from a manuſcript in the Cotton library, Dublin, 1633, folio. He wrote alſo *Chronologia univerſalis*, a very learned work; and various other tracts.

CAMPICURSIO, in the ancient military art, a march of armed men for ſeveral miles, from and back again to the camp, to inſtruct them in the military pace. This exerciſe was nearly akin to the *decurſio*, from which it only differed, in that the latter was performed by horſemen, the former alſo by foot.

CAMPIDOCTORES, or CAMPIDUCTORES, in the Roman army, were officers who inſtructed the ſoldiery in the diſcipline and exerciſes of war, and the art of handling their weapons to advantage. Theſe are alſo ſometimes called *campigeni*, and *armidoctores*.

CAMPIDUCTOR, in middle-age writers, ſignifies the leader or commander of an army, or party.

CAMPION, in *Botany*, the Engliſh name of the LYCHNIS.

CAMPION, a town of the kingdom of Tangut in Tartary. It was formerly remarkable for being a place through which the caravans paſſed in the road from Bukharia to China. E. Long. 104. 53. N. Lat. 40. 25.

CAMPISTRON, a celebrated French dramatic author, was born in 1656. Racine directed his poetical talents to the theatre, and aſſiſted him in his firſt pieces. He died in 1723.

CAMPITÆ, in church hiſtory, an appellation given to the Donatiſts, on account of their aſſembling in the fields for want of churches. For a ſimilar reaſon, they were alſo denominated *Montenſes* and *Rupitani*.

CAMPLI, or CAMPOLI, a town of Italy, in the kingdom of Naples, and in the farther Abruzzo, ſituated in E. Long. 13. 55. N. Lat. 42. 38.

CAMPO MAJOR, a town of the province of Alentejo in Portugal. W. Long. 7. 24. N. Lat. 38. 50.

CAMPREDON, a town of Catalonia in Spain, ſeated at the foot of the Pyrenean mountains. The fortifications were demoliſhed by the French in 1691. W. Long. 1. 56. N. Lat. 42. 20.

CAMPS, FRANCIS DE, abbot of Notre Dame at Sigi, was born at Amiens in 1643; and diſtinguiſhed himſelf by his knowledge of medals, by writing a hiſtory of France, and ſeveral other works. He died at Paris in 1723.

CAMPVERE. See VEER.

CAMPUS, in antiquity, a field or vacant plain in a city, not built upon, left vacant on account of ſhows, combats, exerciſes, or other uſes of the citizens.

CAMPUS Maii, in ancient cuſtoms, an anniverſary aſſembly of our anceſtors held on May-day, when they confederated together for the defence of the kingdom againſt all its enemies.

CAMPUS Martius, a large plain in the ſuburbs of ancient Rome, lying between the Quirinal and Capitoline mounts and the Tiber, thus called becauſe conſecrated to the god Mars, and ſet apart for military ſports and exerciſes to which the Roman youth were trained, as the uſe and handling of arms, and all manner of feats of activity. Here were the races run, either with chariots or ſingle horſes; here alſo ſtood the villa publica, or palace for the reception of ambaſſadors, who were not permitted to enter the city. Many of the public comitia were held in the ſame field, part of which was for that purpoſe cantoned out. The place was alſo nobly decorated with ſtatues, arches, columns, porticoes, and the like ſtructures.

CAMPUS Sceleratus, a place without the walls of ancient Rome, where the Veſtals who had violated their vows of virginity were buried alive.

CAMUL, a town of Aſia, on the eaſtern extremity of the kingdom of Cialus, on the frontiers of Tangut. E. Lon. 98. 5. N. Lat. 37. 15.

CAMUS, a perſon with a low flat noſe, hollowed in the middle.

The Tartars are great admirers of camus beauties. Rubruquis obſerves, that the wife of the great Jenghiz Khan, a celebrated beauty, had only two holes for a noſe.

CAMUS, *John Peter*, a French prelate born in 1582. He was author of a number of pious romances (the taſte of his time), and other theological works, to the amount of 200 vols. His definition of politics is remarkable: *Ars non tam regendi, quam fallendi, homines;* "The art not ſo much of governing, as of deceiving mankind." He died in 1652.

CAN, in the ſea-language, as can-pump, a veſſel wherewith ſeamen pour water into the pump to make it go.

CAN-Buoy. See BUOY.

CAN-Hook, an inſtrument uſed to ſling a caſk by the ends of the ſtaves: it is formed by fixing a broad and flat hook at each end of a ſhort rope; and the tackle by which the caſk ſo ſlung may be hoiſted or lowered, is hooked to the middle of the rope.

CANA, in *Ancient Geography*, a town on the confines of the Upper and Lower Galilee; memorable for the turning water into wine (John). The birth place of Simeon, called *Canaanite* from this place, and of Nathanael.

CANAAN, the fourth ſon of Ham. The irreverence of Ham towards his father Noah is recorded in Gen. ix. Upon that occaſion the patriarch curſed him in a branch of his poſterity: "Curſed," ſays he, "be Canaan; a ſervant of ſervants ſhall he be unto his brethren." This curſe being pronounced, not againſt Ham the immediate tranſgreſſor, but againſt his ſon, who does not appear, from the words of Moſes, to have been any wiſe concerned in the crime, hath occaſioned ſeveral conjectures. Some have believed that Noah curſed Canaan, becauſe he could not well have curſed Ham himſelf, whom God had not long before bleſſed. Others think Moſes's chief intent in recording this prediction was to raiſe the ſpirits of the Iſraelites, then entering on a terrible war with the children of Canaan, by the aſſurance, that, in conſequence of the curſe, that people were deſtined by God to be ſubdued by them. For the opinion of theſe who imagine all Ham's race were here accurſed, ſeems repugnant to the plain words of Scripture, which confines the malediction to Canaan and his poſterity; and is alſo contrary to fact. Indeed, the prophecy of Noah, that "Canaan ſhould be a ſervant of ſervants to his brethren," ſeems to have been wholly completed in him. It was completed with regard to Shem, not only in that a conſiderable part of the ſeven nations of the Canaanites were made ſlaves to the Iſraelites, when they took poſſeſſion of their land, as part of the remainder of them were afterwards enſlaved by Solomon; but alſo by the ſubſequent expeditions of the Aſſyrians and Perſians, who were both deſcended from Shem; and under whom the Canaanites ſuffered ſubjection, as well as the Iſraelites; not to mention the conqueſt of part of Canaan by the Elamites, or Perſians, under Chedorlaomer, prior to them all. With regard to Japhet, we find a completion of the prophecy, in the ſucceſſive conqueſts of the Greeks and Romans in Paleſtine and Phœnicia, where the Canaanites were ſettled; but eſpecially in the total ſubverſion of the Carthaginian power by the Romans; beſides ſome invaſions of the northern nations, as the poſterity of Thogarma and Magog; wherein many of them, probably, were carried away captive.

The poſterity of Canaan were very numerous. His eldeſt ſon was Sidon, who at leaſt founded and peopled the city of Sidon, and was the father of the Sidonians and Phœnicians. Canaan had beſides ten ſons, who were the fathers of ſo many peoples, dwelling in Paleſtine, and in part of Syria; namely, the Hittites, the Jebuſites, the Amorites, the Girgaſites, the Hivites, the Arkites, the Sinites, the Arvadites, the Zemarites, and Hamathites.

Land of CANAAN, the country ſo named from Canaan the ſon of Ham. It lies between the Mediterranean ſea and the mountains of Arabia, and extends from Egypt to Phœnicia. It is bounded to the eaſt by the mountains of Arabia; to the ſouth by the wilderneſs of Paran, Idumæa, and Egypt; to the weſt by the Mediterranean, called in Hebrew the Great ſea; to the north by the mountains of Libanus. Its length from the city of Dan (ſince called Cæſarea Phillippi, or Paneadis, which ſtands at the foot of theſe mountains) to Beerſheba, is about 70 leagues; and its breadth from the Mediterranean ſea to the eaſtern borders, is in ſome places 30. This country, which was firſt called Canaan, from Canaan the ſon of Ham, whoſe poſterity poſſeſſed it, was afterwards called Paleſtine, from the people which the Hebrews call Philiſtines, and the Greeks and Romans corruptly Paleſtines, who inhabited the ſea coaſts, and were firſt known to them. It likewiſe had the name of the *Land of Promiſe*, from the promiſe God made Abraham of giving it to him; that of the *Land of Iſrael*, from the Iſraelites having made themſelves maſters of it; that of *Judah*, from the tribe of Judah, which was the moſt conſiderable of the twelve; and laſtly, the happineſs it had of being ſanctified by the preſence, actions, miracles, and death of Jeſus Chriſt, has given it the name of the *Holy Land*, which it retains to this day.

The firſt inhabitants of this land therefore were the Canaanites, who were deſcended from Canaan, and the eleven ſons of that patriarch. Here they multiplied extremely; trade and war were their firſt occupations; theſe gave riſe to their riches, and the ſeveral colonies ſcattered by them over almoſt all the iſlands and maritime provinces of the Mediterranean. The meaſure of their idolatry and abominations was completed, when God delivered their country into the hands of the Iſraelites. In St Athanaſius's time, the Africans ſtill ſaid they were deſcended from the Canaanites; and it is ſaid, that the Punic tongue was almoſt entirely the ſame with the Canaanitiſh and Hebrew language. The colonies which Cadmus carried into Thebes in Bœotia, and his brother Cilix into Cilicia, came from the ſtock of Canaan. The iſles of Sicily, Sardinia, Malta, Cyprus, Corfu, Majorca, and Minorca, Gades and Ebuſus, are thought to have been peopled by the Canaanites. Bochart, in his large work entitled *Canaan*, has ſet all this matter in a good light.

Many of the old inhabitants of the north-weſt of the land of Canaan, however, particularly on the coaſt or territories of Tyre and Sidon, were not driven out by the children of Iſrael, whence this tract ſeems to have retained the name of Canaan a great while after thoſe other parts of the country, which were better inhabited by the Iſraelites, had loſt the ſaid name. The Greeks called this tract inhabited by the old Canaanites along the Mediterranean ſea, Phœnicia; the more inland parts, as being inhabited partly by Canaanites, and partly by Syrians, Syrophœnicia: and hence the woman ſaid by St Matthew (xv. 22.) to be a woman of Canaan, whoſe daughter Jeſus cured, is ſaid by St Mark (vii. 26.) to be a Syrophœnician by nation, as ſhe was a Greek by religion and language.

CANABAC, an iſland which lies contiguous to BULAM on the weſtern coaſt of Africa, and is inhabited by a fierce people, governed by two kings or chiefs. It would appear that the Canabacs had been very troubleſome to their neighbours; for the inhabitants of ſome other iſlands in that cluſter rejoiced at the ſettlement of the Engliſh in Bulam, hoping to find in them a defence againſt the uſurpations of this people.

CANADA, or the province of Quebec, an extenſive country of North America, bounded on the north-eaſt by the gulf of St Lawrence, and St John's river; on the ſouth-weſt, by lands inhabited by the ſavage Indians, which are frequently included in this province; on the ſouth, by the provinces of Nova Scotia, New England, and New York; and on the north-weſt, by other Indian nations. Under the name of *Canada*, the French comprehended a very large territory; taking into their claim part of New Scotland, New England, and New York on the eaſt; and extending it on the weſt as far as the Pacific ocean. That part, however, which was reduced by the Britiſh arms in the laſt war, lies between 61 and 81 degrees of weſt longitude, and between 45 and 52 of north latitude. The climate is not very different from that of the northern Britiſh colonies; but as it is much further from the ſea, and more to the northward, than moſt of thoſe provinces, it has a much ſeverer winter, though the air is generally clear; and, like moſt of thoſe American tracts that do not lie too far to the northward, the ſummers are very hot, and exceeding pleaſant. The ſoil in general is very good, and in many parts extremely fertile; producing many different ſorts of grains, fruits, and vegetables. The meadow grounds, which are well watered, yield excellent graſs, and breed vaſt numbers of great and ſmall cattle. The uncultivated parts are a continued wood, compoſed of prodigiouſly large and lofty trees, of which there is ſuch a variety of ſpecies, that even of thoſe who have taken moſt pains to know them, there is not perhaps one that can tell half the number. Canada produces, among others, two ſorts of pines, the white and the red; four ſorts of firs; two ſorts of cedar and oak, the white and the red; the male and female maple; three ſorts of aſh trees, the free, the mungrel, and the baſtard; three ſorts of walnut-trees, the hard, the ſoft, and the ſmooth; vaſt numbers of beech-trees and white wood; white and red elms, and poplars. The Indians hollow the red elms into canoes, ſome of which made out of one piece will contain 20 perſons: others are made of the bark; the different pieces of which they ſew together with the inner rind, and daub over the ſeams with pitch, or rather a bituminous matter reſembling pitch, to prevent their leaking; the ribs of theſe canoes are made of boughs of trees. In the hollow elms, the bears and wild cats take up their lodging from November to April. The country produces alſo a vaſt variety of other vegetables, particularly tobacco, which thrives well. Near Quebec is a fine lead mine, and many excellent ones of iron have been diſcovered. It hath alſo been reported that ſilver is found in ſome of the mountains. The rivers are extremely numerous, and many of them very large and deep. The principal are, the Ouattauais, St John's, Seguinay, Deſpaires, and Trois Rivieres; but all theſe are ſwallowed up by the great river St Lawrence. This river iſſues from the lake Ontario; and, taking its courſe north-eaſt, waſhes Montreal, where it receives the Ouattauais, and forms many fertile iſlands. It continues the ſame courſe, and meets the tide upwards of 400 miles from the ſea, where it is navigable for large veſſels; and below Quebec, 320 miles from the ſea, it becomes ſo broad and ſo deep, that ſhips of the line contributed in the laſt war to reduce that city. After receiving in its progreſs innumerable ſtreams, it at laſt falls into the ocean at Cape Roſiers, where it is 90 miles broad, and where the cold is intenſe and the ſea boiſterous. This river is the only one upon which any ſettlements of note are as yet formed; but it is very probable, that, in time to come, Canada, and thoſe vaſt regions to the weſt, may be enabled of themſelves to carry on a conſiderable trade upon the great lakes of freſh water which theſe countries environ. Here are five lakes, the leaſt of which is of greater extent than the freſh-water lakes to be found in any other part of the world: theſe are the lake Ontario, which is not leſs than 200 leagues in circumference; Erie, or Oſwego, longer, but not ſo broad, is about the ſame extent. That of the Huron ſpreads greatly in width, and is about 300 leagues in circuit; as alſo is that of Michigan, though like lake Erie it is rather long, and comparatively narrow. But the lake Superior is larger than any of theſe, being not leſs than 500 leagues in circumference. All theſe are navigable by any veſſels, and they all communicate with each other; but the paſſage between Erie and Ontario is interrupted by a moſt ſtupendous fall or cataract, called the *falls of Niagara* *. The river St Lawrence, as already obſerved, is the outlet of theſe lakes, by which they diſcharge themſelves into the ocean. The French built forts at theſe ſeveral ſtraits, by which the lakes communicate with one another, and on that where the laſt of them communicates with the river. By theſe, while the country was in their poſſeſſion, they effectually ſecured to themſelves the trade of the lakes, and preſerved an influence over all the Indian nations that lie near them.

The moſt curious and intereſting part of the natural hiſtory of Canada is the animals there produced. Theſe are ſtags, elks, deer, bears, foxes, martins, wild cats, ferrets, weaſels, large ſquirrels of a greyiſh hue, hares and rabbits. The ſouthern parts, in particular, breed great numbers of wild bulls, divers ſorts of roebucks, goats, wolves, &c. The marſhes, lakes, and pools, with which this country abounds, ſwarm with otters and beavers, of which the white are highly valued, as well as the right black kind. A vaſt variety of birds are alſo to be found in the woods; and the river St Lawrence abounds with ſuch quantities of fiſh, that it is affirmed by ſome writers, this would be a more profitable article than even the fur-trade.—There are

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* See *Niagara*.

Canada.

in Canada a multitude of different Indian tribes: but theſe are obſerved to decreaſe in number where the Europeans are moſt numerous; owing chiefly to the immoderate uſe of ſpirituous liquors, of which they are exceſſively fond. Their manners and way of living we have already particularly deſcribed †. The principal towns are Quebec, Trois Rivieres, and Montreal. The commodities required by the Canadians from Europe are, wine, or rather rum; cloths, chiefly coarſe; linens, and wrought iron. The Indian trade requires rum, tobacco, a ſort of duffil blankets, guns, powder, balls, and flints, kettles, hatchets, toys, and trinkets of all kinds. While the country was in poſſeſſion of the French, the Indians ſupplied them with poultry; and the French had traders, who, like the original inhabitants, traverſed the vaſt lakes and rivers in canoes, with incredible induſtry and patience, carrying their goods into the remoteſt parts of America, and among nations entirely unknown to us. Theſe again brought the furs, &c. home to them, as the Indians were thereby habituated to trade with them. For this purpoſe, people from all ports, even from the diſtance of 1000 miles, came to the French fair at Montreal, which began in June, and ſometimes laſted three months. On this occaſion many ſolemnities were obſerved, guards were placed, and the governor aſſiſted to preſerve order in ſo great and various a concourſe of ſavage nations. But ſometimes great diſorders and tumults happened; and the Indians frequently gave for a dram all that they were poſſeſſed of. It is remarkable, that many of theſe nations actually paſſed by the Engliſh ſettlement of Albany in New York, and travelled 200 miles further to Montreal, though they could have purchaſed the goods they wanted cheaper at the former.

Since Britain became poſſeſſed of Canada, our trade with that country has generally employed 34 ſhips and 400 ſeamen; their exports, at an average of three years, in ſkins, furs, ginſeng, ſnake-root, capillaire, and wheat, amount to 150,000l. Their imports from Great Britain are computed at nearly the ſame ſum. It will, however, be almoſt impoſſible to overcome certain inconveniencies ariſing from the violence of the winter. This is ſo exceſſive from December to April, that the broadeſt rivers are frozen over, and the ſnow lies commonly from four to ſix feet deep on the ground, even in thoſe parts of the country which lie three degrees ſouth of London, and in the temperate latitude of Paris. Another inconvenience ariſes from the falls in the river St Lawrence below Montreal, which prevent ſhips from penetrating to that emporium of inland commerce. Our communication therefore with Canada, and the immenſe regions beyond it, will always be interrupted during the winter-ſeaſon, until roads are formed that can be travelled without danger from the Indians. For theſe ſavage people often commit hoſtilities againſt us without any previous notice; and frequently, without any provocation, they commit the moſt horrid ravages for a long time with impunity.

Canada was undoubtedly diſcovered by Sebaſtian Cabot, the famous Italian adventurer, who ſailed under a commiſſion from Henry VII. But though the Engliſh monarch did not think proper to make any uſe of this diſcovery, the French quickly attempted it; we have an account of their fiſhing for cod on the banks of Newfoundland, and along the ſea-coaſt of Canada, in the beginning of the 16th century. About the year 1506, one Denys, a Frenchman, drew a map of the gulf of St Lawrence; and two years after, one Aubort, a ſhip-maſter of Dieppe, carried over to France ſome of the natives of Canada. As the new country, however, did not promiſe the ſame amazing quantities of gold and ſilver produced by Mexico and Peru, the French for ſome years neglected the diſcovery. At laſt, in the year 1523, Francis I. a ſenſible and enterpriſing prince, ſent four ſhips, under the command of Verazani, a Florentine, to proſecute diſcoveries in that country. The particulars of this man's firſt expedition are not known. All we can learn is, that he returned to France, and next year he undertook a ſecond. As he approached the coaſt, he met with a violent ſtorm; however, he came ſo near as to perceive the natives on the ſhore, making friendly ſigns to him to land. This being found impracticable by reaſon of the ſurf upon the coaſt, one of the ſailors threw himſelf into the ſea; but, endeavouring to ſwim back to the ſhip, a ſurge threw him on ſhore without ſigns of life. He was, however, treated by the natives with ſuch care and humanity, that he recovered his ſtrength, and was allowed to ſwim back to the ſhip, which immediately returned to France. This is all we know of Verazani's ſecond expedition. He undertook a third, but was no more heard of, and it is thought that he and all his company periſhed before he could form any colony. In 1534, one Jaques Cartier of St Maloes ſet ſail under a commiſſion from the French king, and on the 10th of May arrived at Cape Bonaviſta in Newfoundland. He had with him two ſmall ſhips beſides the one in which he ſailed. He cruiſed along the coaſt of that iſland, on which he diſcovered inhabitants, probably the Eſkimaux. He landed in ſeveral places along the coaſt of the gulf, and took poſſeſſion of the country in the king's name. On his return, he was again ſent out with a commiſſion, and a pretty large force: he returned in 1535, and paſſed the winter at St Croix; but the ſeaſon proved ſo ſevere, that he and his companions muſt have died of the ſcurvy, had they not, by the advice of the natives, made uſe of the decoction of the tops and bark of the white pines. As Cartier, however, could produce neither gold nor ſilver, all that he could ſay about the utility of the ſettlement was diſregarded; and in 1540, he was obliged to become pilot to one M. Roberval, who was by the French king appointed viceroy of Canada, and who ſailed from France with five veſſels. Arriving at the gulf of St Lawrence, they built a fort; and Cartier was left to command the garriſon in it, while Roberval returned to France for additional recruits to his new ſettlement. At laſt, having embarked in 1549, with a great number of adventurers, neither he nor any of his followers were heard of more.

This fatal accident ſo greatly diſcouraged the court of France, that for 50 years, no meaſures were taken for ſupplying with neceſſaries the ſettlers that were left. At laſt, Henry IV. appointed the marquis de la Roche lieutenant-general of Canada and the neighbouring countries. In 1598 he landed on the iſle of Sable, which he abſurdly thought to be a proper place for a ſettlement, though it was without any port, and without product except briars. Here he left about 40 malefactors, the refuſe of the French jails. After cruizing

† See *America*.

for ſome time on the coaſt of Nova Scotia, without being able to relieve theſe poor wretches, he returned to France, where he died of a broken heart. His colony muſt have periſhed, had not a French ſhip been wrecked on the iſland, and a few ſheep driven upon it at the ſame time. With the boards of the ſhip they erected huts; and while the ſheep laſted they lived on them, feeding afterwards on fiſh. Their clothes wearing out, they made coats of ſeal-ſkin; and in this miſerable condition they ſpent ſeven years, when Henry ordered them to be brought to France. The king had the curioſity to ſee them in their ſeal-ſkin dreſſes, and was ſo moved with their appearance, that he forgave them all their offences, and gave each of them 50 crowns to begin the world anew.

In 1600, one Chauvin, a commander in the French navy, attended by a merchant of St Malo, called *Pontgrave*, made a voyage to Canada, from whence he returned with a very profitable quantity of furs. Next year he repeated the voyage with the ſame good fortune, but died while he was preparing for a third. The many ſpecimens of profit to be made by the Canadian trade, at laſt induced the public to think favourably of it. An armament was equipped, and the command of it given to Pontgrave, with powers to extend his diſcoveries up the river St Lawrence. He ſailed in 1603, having in his company Samuel Champlain, who had been a captain in the navy, and was a man of parts and ſpirit. It was not, however, till the year 1608, that the colony was fully eſtabliſhed. This was accompliſhed by founding the city of Quebec, which from that time commenced the capital of all the ſettlements in Canada. The colony, however, for many years continued in a low way, and was often in danger of being totally exterminated by the Indians. As the particulars of theſe wars, however, could neither be entertaining, nor indeed intelligible, to many of our readers, we chooſe to omit them, and in general obſerve, that the French not only concluded a permanent peace with the Indians, but ſo much ingratiated themſelves with them, that they could with the greateſt eaſe prevail upon them at any time to murder and ſcalp the Engliſh in their ſettlements. Theſe practices had a conſiderable ſhare in bringing about the laſt war with France, when the whole country was conquered by the Britiſh in 1761. The moſt remarkable tranſaction in this conqueſt was the ſiege of QUEBEC; for a particular account of which, ſee that article. And for the tranſactions here during the late American war, ſee AMERICA (United States of).

CANAL *of* COMMUNICATION, an artificial cut in the ground, ſupplied with water from rivers, ſprings, &c. in order to make a navigable communication betwixt one place and another.

The particular operations neceſſary for making artificial navigations depend upon a number of circumſtances. The ſituation of the ground; the vicinity or connection with rivers; the eaſe or difficulty with which a proper quantity of water can be obtained; theſe and many other circumſtances neceſſarily produce great variety in the ſtructure of artificial navigations, and augment or diminiſh the labour and expence of executing them. When the ground is naturally level, and unconnected with rivers, the execution is eaſy, and the navigation is not liable to be diſturbed with floods: but, when the ground riſes and falls, and cannot be reduced to a level, artificial methods of raiſing and lowering veſſels muſt be employed; which likewiſe vary according to circumſtances.

A kind of temporary ſluices are ſometimes employed for raiſing boats over falls or ſhoals in rivers by a very ſimple operation. Two poſts or pillars of maſon-work, with grooves, are fixed, one on each bank of the river, at ſome diſtance below the ſhoal. The boat having paſſed theſe poſts, planks are let down acroſs the river by pullies into the grooves, by which the water is dammed up to a proper height for allowing the boat to paſs up the river over the ſhoal.

The Dutch and Flemings at this day ſometimes, when obſtructed by caſcades, form an inclined plane or rolling-bridge upon dry land, alongſt which their veſſels are drawn from the river below the caſcade into the river above it. This, it is ſaid, was the only method employed by the ancients, and is ſtill uſed by the Chineſe, who are ſaid to be entirely ignorant of the nature and utility of locks. Theſe rolling-bridges conſiſt of a number of cylindrical rollers which turn eaſily on pivots, and a mill is commonly built near by, ſo that the ſame machinery may ſerve the double purpoſe of working the mill and drawing up veſſels.

A LOCK is a baſon placed lengthwiſe in a river or canal, lined with walls of maſonry on each ſide, and terminated by two gates, placed where there is a caſcade or natural fall of the country; and ſo conſtructed, that the baſon being filled with water by an upper ſluice to the level of the waters above, a veſſel may aſcend through the upper gate; or the water in the lock being reduced to the level of the water at the bottom of the caſcade, the veſſel may deſcend through the lower gate; for when the waters are brought to a level on either ſide, the gate on that ſide may be eaſily opened. But, as the lower gate is ſtrained in proportion to the depth of water it ſupports, when the perpendicular height of the water exceeds 12 or 13 feet, more locks than one become neceſſary. Thus, if the fall be 17 feet, two locks are required, each having 8½ feet fall; and if the fall be 26 feet, three locks are neceſſary, each having 8 feet 8 inches fall. The ſide walls of a lock ought to be very ſtrong. Where the natural foundation is bad, they ſhould be founded on piles and platforms of wood: they ſhould likewiſe ſlope outwards, in order to reſiſt the preſſure of the earth from behind.

Plate CXXXIV. fig. 1. A perſpective view of part of a canal: the veſſel L, within the lock AC.—Fig. 2. Section of an open lock: the veſſel L about to enter.—Fig. 3. Section of a lock full of water; the veſſel L. raiſed to a level with the water in the ſuperior canal.—Fig. 4. Ground ſection of a lock. L, a veſſel in the inferior canal. C, the under gate. A, the upper gate. GH, a ſubterraneous paſſage for letting water from the ſuperior canal run into the lock. KF, a ſubterraneous paſſage for water from the lock to the inferior canal.

X and Y, (fig. 1.) are the two floodgates, each of which conſiſts of two leaves, reſting upon one another, ſo as to form an obtuſe angle, in order the better to reſiſt the preſſure of the water. The firſt (X) prevents the water of the ſuperior canal from falling into the lock; and the ſecond (Y) dams up and ſuſtains,

ſtains the water in the lock. Theſe flood-gates ought to be very ſtrong, and to turn freely upon their hinges. In order to make them open and ſhut with eaſe, each leaf is furniſhed with a long lever A *b*, A *b*; C *b*, C *b*. They ſhould be made very tight and cloſe, that as little water as poſſible may be loſt.

By the ſubterraneous paſſage G H (fig. 2, 3 & 4.) which deſcends obliquely, by opening the ſluice G, the water is let down from the ſuperior canal D into the lock, where it is ſtopt and retained by the gate C when ſhut, till the water in the lock comes to be on a level with the water in the ſuperior canal D; as repreſented, fig. 3. When, on the other hand, the water contained by the lock is to be let out, the paſſage G H muſt be ſhut by letting down the ſluice G; the gate A muſt be alſo ſhut, and the paſſage K F opened by raiſing the ſluice K: a free paſſage being thus given to the water, it deſcends through K F, into the inferior canal, until the water in the lock is on a level with the water in the inferior canal B; as repreſented, fig. 2.

Now, let it be required to raiſe the veſſel L (fig. 2.) from the inferior canal B to the ſuperior one D; if the lock happens to be full of water, the ſluice G muſt be ſhut, and alſo the gate A, and the ſluice K opened, ſo that the water in the lock may run out till it is on a level with the water in the inferior canal B. When the water in the lock comes to be on a level with the water at B, the leaves of the gate C are opened by the levers C *b*, which is eaſily performed, the water on each ſide of the gate being in equilibrio; the veſſel then ſails into the lock. After this the gate C and the ſluice K are ſhut, and the ſluice G opened, in order to fill the lock, till the water in the lock, and conſequently the veſſel, be upon a level with the water in the ſuperior canal D; as is repreſented in fig. 3. The gate A is then opened, and the veſſel paſſes into the canal D.

Again, let it be required to make a veſſel deſcend from the canal D into the inferior canal B. If the lock is empty, as in fig. 2. the gate C and ſluice K muſt be ſhut, and the upper ſluice G opened, ſo that the water in the lock may riſe to a level with the water in the upper canal D. Then open the gate A, and let the veſſel paſs through into the lock. Shut the gate A and the ſluice G; then open the ſluice K, till the water in the lock be on a level with the water in the inferior canal; then the gate C is opened, and the veſſel paſſes along into the canal B, as was required.

Scarcity of water becomes a very ſerious inconvenience to navigation in thoſe places where locks are neceſſary, as, without a ſufficient ſupply, it muſt be frequently interrupted. To ſave water, therefore, has been an important conſideration in the conſtruction of locks. Various attempts have been made for this purpoſe. We ſhall here give an account of one which has been propoſed by Mr Playfair architect in London. "The nature and principle of this manner of ſaving water, ſays the inventor, conſiſts in letting the water which has ſerved to raiſe or fall a boat or barge from the lock, paſs into reſervoirs or ciſterns, whoſe apertures of communication with the lock are upon different levels, and which may be placed or conſtructed at the ſide or ſides of the lock with which they communicate, or in any other contiguous ſituation that circumſtances may render eligible; which apertures may be opened or ſhut at pleaſure, ſo that the water may paſs from the lock to each reſervoir of the canal, or from each reſervoir to the lock, in the following manner: The water which fills the lock, when a boat is to aſcend or deſcend, inſtead of being paſſed immediately into the lower part of the canal, is let paſs into theſe ciſterns or reſervoirs, upon different levels; then their communications with the lock being ſhut, they remain full until another veſſel is wanted to paſs; then, again, the ciſterns are emptied into the lock, which is thereby nearly filled, ſo that only the remainder which is not filled is ſupplied from the higher part of the canal. Each of theſe ciſterns muſt have a ſurface not leſs than that of the lock, and muſt contain half as much water as is meant to be expended for the paſſing of each veſſel. The ciſtern the moſt elevated is placed twice its own depth (meaſuring by the aperture, or communicating opening of the ciſterns) under the level of the water in the higher part of the canal. The ſecond ciſtern is placed once its own depth under the firſt, and ſo on are the others, to the loweſt; which laſt is placed once its own depth above the level of the water in the lower part of the canal. The apertures of the intermediate ciſterns, whatever their number may be, muſt all be equally divided into different levels; the ſurface of the water in the one being always on the level of the bottom of the aperture of the ciſtern which is immediately above. As an example of the manner and rule for conſtructing theſe ciſterns, ſuppoſe that a lock is to be conſtructed twelve feet deep, that is, that the veſſel may aſcend or deſcend twelve feet in paſſing. Suppoſe the lock ſixty feet long and ſix feet wide, the quantity of water required to fill the lock, and to paſs a boat, is 4320 cubic feet; and ſuppoſe that, in calculating the quantity of water that can be procured for ſupplying the canal, after allowing for waſte, it is found (according to the number of boats that may be expected to paſs) that there will not be above 800 cubic feet for each; then it will be neceſſary to ſave five-ſixths of the whole quantity that in the common caſe would be neceſſary: to do which ten ciſterns muſt be made (the mode of placing which is expreſſed in the drawing, fig. 5. Plate CXXXIV,) each of which muſt be one foot deep, or deeper at pleaſure, and each muſt have a ſurface of 360 feet ſquare, equal to the ſurface of the lock. The bottom of the aperture of the loweſt ciſtern muſt be placed one foot above the level of the water in the lower part of the canal, or eleven feet under the level of the high water; the ſecond ciſtern muſt be two feet above the level of the low water; the third three feet, and ſo on of the others; the bottom of the tenth, or uppermoſt ciſtern, being ten feet above the low water, and two feet lower than the high water; and, as each ciſtern muſt be twelve inches in depth, the ſurface of the water in the higher ciſtern will be one foot under the level of the water in the upper part of the canal. The ciſterns being thus conſtructed, when the lock is full, and the boat to be let down, the communications between the lock and the ciſterns, which until then have all been ſhut, are to be opened in the following manner; firſt, the communication with the higher ciſtern is opened, which, being at bottom two feet under the level of the water in the lock, is filled to the depth of one foot, the water in the lock deſcending one foot alſo at the ſame time; that communication is then ſhut, and the communication between the lock and the ſecond ciſtern is opened; one foot more of the water then paſſes into that ciſtern from the lock, and fills it; the opening is then ſhut: the ſame is done with the third, fourth, fifth, ſixth, ſeventh, eighth, ninth, and tenth ciſterns, one by one, until they are all filled; and, when the tenth, or lowermoſt ciſtern, is filled, there remains but two feet depth of water in the lock. The communication between the lock and the lower part of the canal is then opened, and the laſt two feet depth of water is emptied into the lower part of the canal. By this means, it is evident, that, inſtead of twelve feet depth of water being let deſcend into the lower part of the canal, there is only two feet depth that deſcends, or one-ſixth of the whole; therefore, inſtead of 4320 cubic feet being uſed, there are only 720 cubic feet uſed: the remainder of the water in the ciſterns being uſed as follows. When another boat is to mount, the ſluices being then ſhut, and the boat in the lock, the tenth or lowermoſt ciſtern, is emptied into the lock, which it fills one foot; the communication being then ſhut, the next loweſt ciſtern, or the ninth, is emptied into the lock, which is thereby filled another foot; and ſo in like manner, all the other ciſterns are emptied, one after another, until the higher ciſtern being emptied, which fills the tenth foot of water in the lock, there remains but two feet of water to fill, which is done from the upper part of the canal, by opening the higher ſluice to paſs the boat; by that means, the ſame quantity of water deſcends from the upper part of the canal into the lock that in the other caſe deſcended from the lock into the lower part of the canal; ſo that, in both caſes, the ſame quantity of water is ſaved, that is, five-ſixths of what would be neceſſary were there no ciſterns. Suppoſe again that, upon the ſame canal, and immediately after the twelve feet lock, it would be advantageous to conſtruct one of eighteen feet; then, in order not to uſe any greater quantity of water, it will be neceſſary to have ſixteen ciſterns, upon different levels, communicating with the lock in the ſame manner. Should, again, a lock of only ſix feet be wanted, after that of eighteen, then it will only be neceſſary to have four ciſterns on different levels, and ſo of any other height of lock. The rule is this: for finding the number and ſize of the ciſterns, each ciſtern being the ſame in ſuperficies with the lock, its depth muſt be ſuch as to contain one half the quantity of water meant to be uſed in the paſſing of one boat. The depth of the lock, divided by the depth neceſſary for ſuch a ciſtern, will give, in all caſes, the whole number of ciſterns, and two more: deduct the number two, therefore, from the number which you find by dividing the depth of the lock by the depth of one ciſtern, and you have always the number of ciſterns required; which are to be placed upon different levels, according to the rule already given. The above is the principle and manner of uſing the lock, for ſaving water in canals, and for enabling engineers to conſtruct locks of different depths upon the ſame canal, without uſing more water for the deep locks than for the ſhallow ones. With regard to the manner of diſpoſing the ciſterns, the circumſtances of the ground, the declivity, &c. will be the beſt guide for the engineer."

But even when water is abundant, if the declivity of a country be ſuch as to require numerous locks, navigation ſuffers great interruption from them. A method by which boats could be raiſed and lowered with greater facility, or in a ſhorter time than can be done by means of locks is ſtill a very deſirable object of improvement in inland navigation. For this purpoſe the inclined plane has been often reſorted to, and particularly in China, where water-carriage is more generally employed than in any country of Europe. But this method requires very powerful machinery or a great number of hands, which has prevented it from being much practiſed in this country. Other contrivances to obviate the uſe of locks have been propoſed. Dr Anderſon, in his Agricultural Survey of the County of Aberdeen, has deſcribed one, of which we ſhall give an account in his own words. This contrivance, he obſerves, "in the opinion of very good judges of matters of this ſort, to whom the plan has been ſhewn, has been deemed fully adequate to the purpoſe of raiſing and lowering boats of a moderate ſize, that is, of 20 tons, or downwards; and it is the opinion of moſt men with whom I have converſed, who are beſt acquainted with the inland navigations, that a boat of from 10 to 15 tons is better than thoſe of a larger ſize. When ſeveral are wanted to be ſent at once, they may be affixed to one another, as many as the towing-horſe can conveniently draw. Were boats of this ſize adopted, and were all the boats on one canal to be of the ſame dimenſions, it would prove a great convenience to a country in a ſtate of beginning improvements; becauſe the expence of ſuch a boat would be ſo trifling, that every farmer could have one for himſelf, and might of courſe make uſe of it when he pleaſed, by the aid of his own horſe, without being obliged to have any dependence on the time that might ſuit the convenience of his neighbour; and if two or more boats were going from the ſame neighbourhood, one horſe could ſerve the whole.

"You are to ſuppoſe that fig. 6. Plate CXXXIV. repreſents a bird's-eye view of this ſimple apparatus, as ſeen from above. A is ſuppoſed to be the upper reach of the canal, and B the lower reach, with the apparatus between the two. This conſiſts of three diviſions; the middle one, extending from C to D, is a ſolid piece of maſonry, raiſed from a firm foundation below the level of the bottom of the ſecond reach; this is again divided into five parts, viz. *d d d*, where the wall riſes only to the height of the water in the upper reach, and *e e*, two pillars, raiſed high enough to ſupport the pivots of a wheel or pulley *g*, placed in the poſition there marked.

"The ſecond diviſion *h* conſiſts of a wooden coffer, of the ſame depth nearly as the water in the upper reach, and of a ſize exactly fitted to contain one of the boats. This communicates directly with the upper reach, and being upon the ſame plane with it, and ſo connected with it as to be water-tight, it is evident, from inſpection, that nothing can be more eaſy than to float a boat into this coffer from the upper reach, the part of the wheel that projects over it being at a ſufficient height above it, ſo as to occaſion no ſort of interruption.

CANAL.

Fig. 1. Perspective View of part of a Canal with Locks.

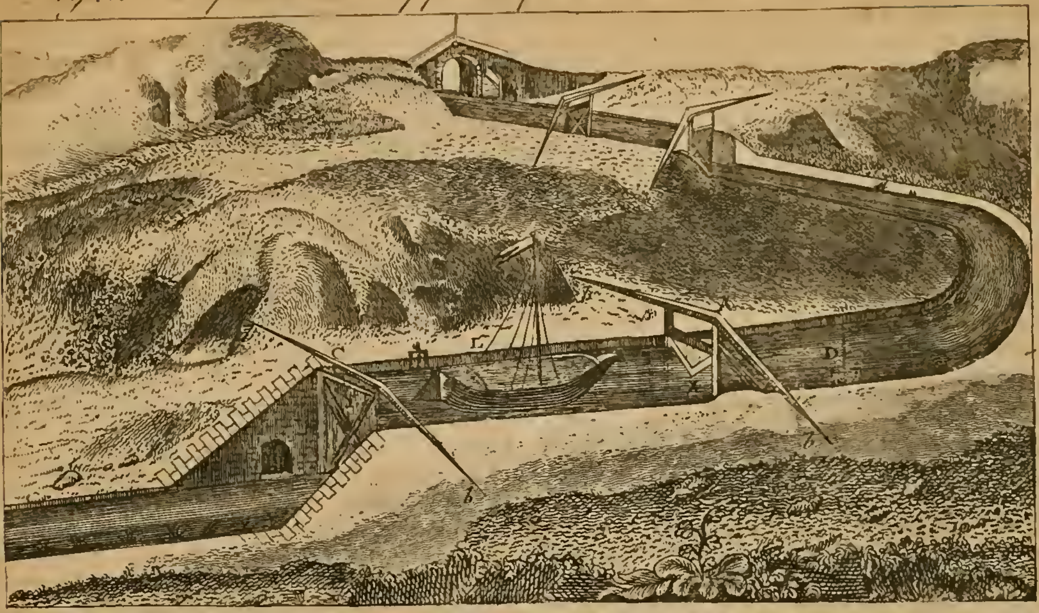


Fig. 7.

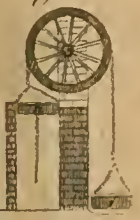


Fig. 8.

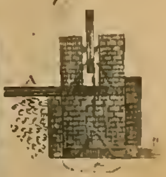


Fig. 2. Section of a Lock.

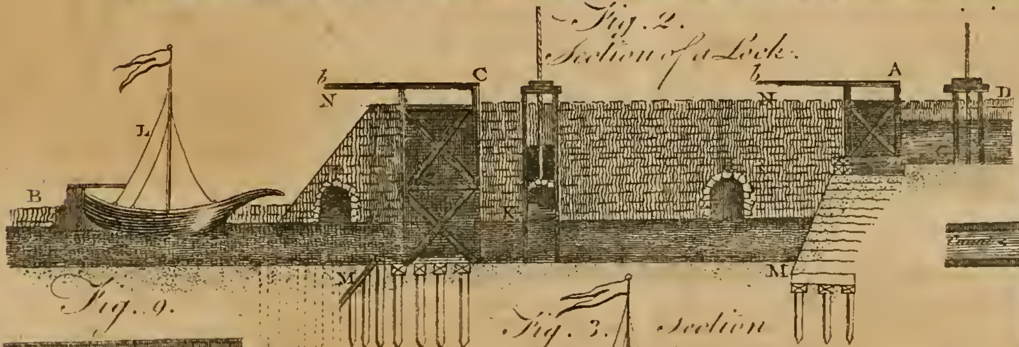


Fig. 5.

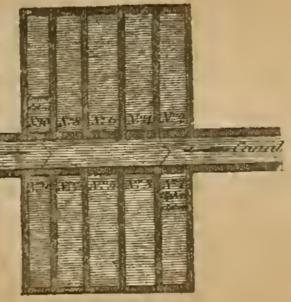


Fig. 9.

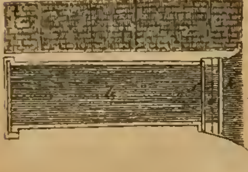


Fig. 3. Section of a Lock full of Water.

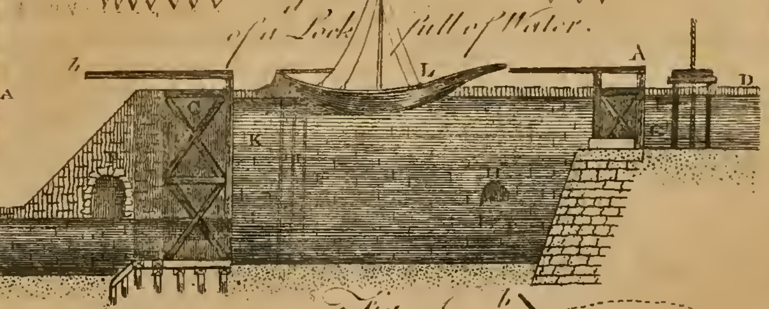


Fig. 6.

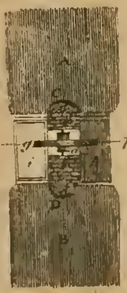


Fig. 10.

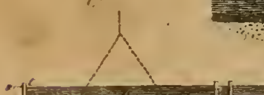
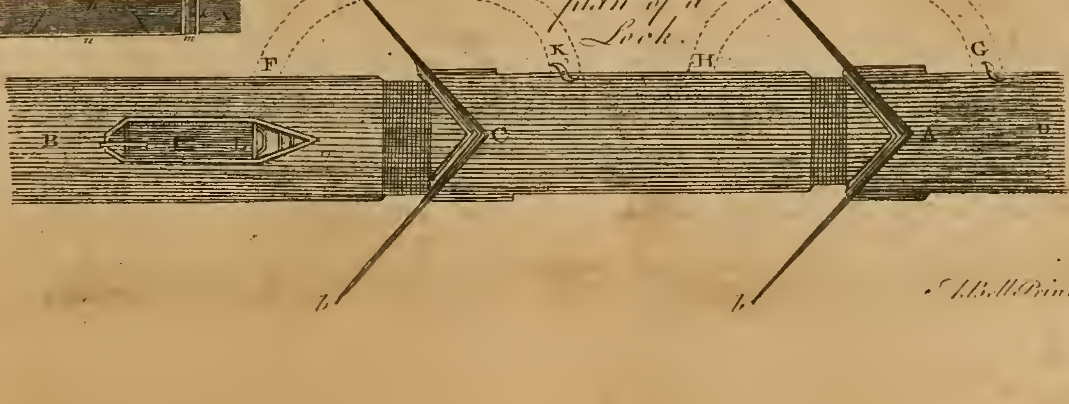


Fig. 4. plan of a Lock.



A. Bell Prin. Wal. Sculptor fecit.

" Third diviſion. At *i* is repreſented another coffer, preciſely of the ſame dimenſions with the firſt. But here two ſluices, which were open in the former, and only repreſented by dotted lines, are ſuppoſed to be ſhut, ſo as to cut off all communication between the water in the canal and that in the coffer. As it was impoſſible to repreſent this part of the apparatus on ſo ſmall a ſcale, for the ſake of illuſtration it is repreſented more at large in fig. 9. where A, as before, repreſents the upper reach of the canal, and *h* one of the coffers. The ſluice *k* goes into two cheeks of wood, joined to the maſonry of the dam of the canal, ſo as to fit perfectly cloſe; and the ſluice *f* fits, equally cloſe, into cheeks made in the ſide of the coffer for that purpoſe; between theſe two ſluices is a ſmall ſpace *o*. The coffer, and this diviſion *o*, are to be ſuppoſed full of water, and it will be eaſy to ſee that theſe ſluices may be let down, or drawn up at pleaſure, with much facility.

" Fig. 10. repreſents a perpendicular ſection of theſe parts in the ſame direction as in fig. 9. and in which the ſame letters repreſent the ſame parts.

" Things being thus arranged, you are to ſuppoſe the coffer *h* to be ſuſpended, by means of a chain paſſed over the pulley, and balanced by a weight that is ſufficient to counterpoiſe it, ſuſpended at the oppoſite end of the chain. Suppoſe, then, that the counterpoiſe be made ſomewhat lighter than the coffer with its contents, and that the line *m n* (fig. 10.) repreſents a diviſion between the ſolid ſides of the dam of ſeparation, which terminates the upper reach, and the wooden coffer, which had been cloſed only by the preſſure of its own weight (being puſhed a very little from A towards B, beyond its preciſe perpendicular ſwing), and that the joining all round is covered with liſts of cloth put upon it for that purpoſe; it is evident that, ſo long as the coffer is ſuſpended to this height, the joining muſt be water-tight; but no ſooner is it lowered down a little than this joining opens, the water in the ſmall diviſion *o* is allowed to run out, and an entire ſeparation is made between the fixed dam and this moveable coffer, which may be lowered down at pleaſure without loſing any part of the water it contained.

" Suppoſe the coffer now perfectly detached, turn to fig. 7. which repreſents a perpendicular ſection of this apparatus, in the direction of the dotted line *p p* (fig. 6.) In fig. 7. *h* repreſents an end view of the coffer, indicated by the ſame letter as in fig. 6. ſuſpended by its chain, and now perfectly detached from all other objects, and balanced by a counterpoiſe *i*, which is another coffer exactly of the ſame ſize, as low down as the level of the lower reach. From inſpection only it is evident, that, in proportion as the one of theſe weights riſes, the other muſt deſcend. For the preſent, then, ſuppoſe that the coffer *h* is by ſome means rendered more weighty than *i*, it is plain it will deſcend while the other riſes; and they will thus continue till *h* comes down to the level of the lower reach, and *i* riſes to the level of the higher one.

" Fig. 8. repreſents a ſection in the direction A B (fig. 6.), in which the coffer *i* (ſeen in both ſituations) is ſuppoſed to have been gradually raiſed from the level of the lower reach B, to that of the higher one where it now remains ſtationary; while the coffer *h* which is concealed behind the maſonry) has deſcended in the mean time to the level of the lower reach, where it cloſes by means of the juncture *r s*, fig. 10. (which juncture is covered with liſts of cloth, as before explained at *m n*, and is of courſe become water-tight,) when, by lifting the ſluice *t*, and the correſponding ſluice at the end of the canal, a perfect communication by water is eſtabliſhed between them If, then, inſtead of water only, this coffer had contained a boat, floated into it from the upper reach, and then lowered down, it is very plain, that when theſe ſluices were removed, after it had reached the level of the lower reach, that boat might have been floated out of the coffer with as much facility as it was let into it above. Here then we have a boat taken from the higher into the lower canal; and, by reverſing this movement, it is very obvious that it might be, with equal eaſe, raiſed from the lower into the higher one. It now only remains that I ſhould explain by what means the equilibrium between theſe counter-balancing weights can be deſtroyed at pleaſure, and the motion of courſe produced.

" It is very evident, that if the two correſponding coffers be preciſely of the ſame dimenſions, their weight will be exactly the ſame when they are both filled to the ſame depth of water. It is equally plain, that ſhould a boat be floated into either or both of them, whatever its dimenſions or weight may be, ſo that it can be contained afloat in the coffer, the weight of the coffer and its contents will continue preciſely the ſame as when it was filled with water only: hence, then, ſuppoſing one boat is to be lowered, or one to be raiſed at a time, or ſuppoſing one to be raiſed and another lowered at the ſame time—they remain perfectly in equilibrium in either place, till it is your pleaſure to deſtroy that equilibrium. Suppoſe, then, for the preſent, that both coffers are loaded with a boat in each, the double ſluices both above and below cloſed: and ſuppoſe alſo that a ſtop-cock *v*, in the under edge of the ſide of the lower coffer (fig. 8. and 10.), is opened, ſome of the water which ſerved to float the boat in the coffer will flow out of it, and conſequently that coffer will become lighter than the higher one; the upper coffer will of courſe deſcend, while the other mounts upwards. When a gentle motion has been thus communicated, it may be prevented from accelerating, merely by turning the ſtop-cock ſo as to prevent the loſs of more water, and thus one coffer will continue to aſcend, and the other to deſcend, till they have aſſumed their ſtations reſpectively; when, in conſequence of a ſtop below, and another above, they are rendered ſtationary at the level of the reſpective canals (A).

" Preciſely the ſame effect will be produced when the coffers are filled entirely with water.

" It is unneceſſary to add more to this explanation, except to obſerve, that the ſpace for the coffer to deſcend into muſt be deeper than the bottom of the lower canal,

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(A) " It does not ſeem neceſſary to adopt any other contrivance than the above for regulating the motions; but if it ſhould be found neceſſary, it would be eaſy to put a ratch-wheel on the ſame axle.

canal, in order to allow a free deſcent for the coffer to the requiſite depth; and of courſe it will be neceſſary to have a ſmall conduit to allow the water to get out of it. Two or three inches free, below the bottom of the canal, is all that would be neceſſary.

"Where the height is inconſiderable, there will be no occaſion for providing any counterpoiſe for the chain, as that will give only a ſmall addition to the weight of the undermoſt coffer, ſo as to make it preponderate, in circumſtances where the two coffers would otherwiſe be in perfect equilibrium: but, where the height is conſiderable, there will be a neceſſity for providing ſuch a counterpoiſe; as, without it, the chain, by becoming more weighty every foot it deſcended, would tend to deſtroy the equilibrium too much, and accelerate the motion to an inconvenient degree. To guard againſt this inconvenience, let a chain of the ſame weight, per foot, be appended at the bottom of each coffer, of ſuch a length as to reach within a few yards of the ground where the coffer is at its greateſt height (ſee fig. 7.); it will act with its whole weight upon the higheſt coffer while in this poſition; but, as that gradually deſcended, the chain would reach the ground, and, being there ſupported, its weight would be diminiſhed in proportion to its deſcent; while the weight of the chain on the oppoſite ſide would be augmented in the ſame proportion, ſo as to counterpoiſe each other exactly, in every ſituation, until the uppermoſt chain was raiſed from the ground. After which it would increaſe its weight no more: and, of courſe, would then give the under coffer that preponderance which is neceſſary for preſerving the machine ſteady. The under coffer, when it reached its loweſt poſition would touch the bottom on its edges, which would then ſupport it, and keep every thing in the ſame poſition, till it was made lighter for the purpoſe of aſcending.

"What conſtitutes one particular excellence of the apparatus here propoſed is, that it is not only unlimited as to the extent of the riſe or depreſſion of which it is ſuſceptible (for it would not require the expenditure of one drop more water to lower it 100 feet than one foot); but it would alſo be eaſy ſo to augment the number of pulleys at any one place as to admit of two, three, four, or any greater number of boats being lowered or elevated at the ſame time; ſo that let the ſucceſſion of boats on ſuch a canal be nearly as rapid as that of carriages upon a highway, none of them need be delayed one moment to wait an opportunity of paſſing: a thing that is totally impracticable where water-locks are employed; for the intercourſe, on every canal conſtructed with water-locks, is neceſſarily limited to a certain degree, beyond which it is impoſſible to force it.

"For example: ſuppoſe a hundred boats are following each other, in ſuch a rapid ſucceſſion as to be only half a minute behind each other: By the apparatus here propoſed, they would all be elevated preciſely as they came; in the other, let it be ſuppoſed that the lock is ſo well conſtructed as that it takes no more than five minutes to cloſe and open it; that is, ten minutes in the whole to each boat (for the lock, being once filled, muſt be again emptied before it can receive another in the ſame direction): at this rate, ſix boats only could be paſſed in an hour, and of courſe it would take ſixteen hours and forty minutes to paſs the whole hundred; and as the laſt boat would reach the lock in the ſpace of fifty minutes after the firſt, it would be detained fifteen hours and fifty minutes before its turn would come to be raiſed. This is an immenſe detention; but if a ſucceſſion of boats, at the ſame rate, were to follow continually, they never could paſs at all. In ſhort, in a canal conſtructed with water-locks, not more than ſix boats, on an average, can be paſſed in an hour, ſo that beyond that extent all commerce muſt be ſtopped; but, on the plan here propoſed, ſixty, or ſix hundred, might be paſſed in an hour, if neceſſary, ſo as to occaſion no ſort of interruption whatever. Theſe are advantages of a very important nature, and ought not to be overlooked in a commercial country.

"This apparatus might be employed for innumerable other uſes as a moving power, which it would be foreign to our preſent purpoſe here to ſpecify. Nor does its power admit of any limitation, but that of the ſtrength of the chain, and of the coffers which are to ſupport the weights. All the other parts admit of being made ſo immoveably firm as to be capable of ſupporting almoſt any aſſignable weight.

"I will not enlarge on the benefits that may be derived from this very ſimple apparatus: its cheapneſs, when compared with any other mode of raiſing and lowering veſſels that has ever yet been practiſed, is very obvious; the waſte of water it would occaſion is next to nothing; and when it is conſidered that a boat might be raiſed or lowered fifty feet nearly with the ſame eaſe as five, it is evident that the interruptions which ariſe from frequent locks would be avoided, and an immenſe ſaving be made in the original expence of the canal, and in the annual repairs.

"It is alſo evident, that an apparatus, on the ſame principle, might be eaſily applied for raiſing coals or metals from a great depth in mines, wherever a very ſmall ſtream of water could be commanded, and where the mine was level-free."

It is almoſt needleſs to ſpend time in enumerating the many advantages which neceſſarily reſult from artificial navigations. Their utility is now ſo apparent, that moſt nations in Europe give the higheſt encouragement to undertakings of this kind wherever they are practicable. The advantages of navigable canals did not eſcape the obſervation of the ancients. From the moſt early accounts of ſociety we read of attempts to cut through large iſthmuſes, in order to make a communication by water, either betwixt different nations, or diſtant parts of the ſame nation, where land-carriage was long and expenſive. Herodotus relates, that the Cnidians, a people of Caria in Aſia Minor, deſigned to cut the iſthmus which joins that peninſula to the continent; but were ſuperſtitious enough to give up the undertaking, becauſe they were interdicted by an oracle. Several kings of Egypt attempted to join the Red ſea to the Mediterranean by a canal. It was begun by Necos the ſon of Pſammeticus, and completed by Ptolemy II. After his reign it was neglected, till it was opened in 635 under the caliphate of Omar, but was again allowed to fall into diſrepair; ſo that it is now difficult to diſcover any traces of it. Both the Greeks and Romans intended to make a canal acroſs the iſthmus of Corinth, which joins the Morea and Achaia, in order to make a navigable paſſage by the Ionian ſea into the Archipelago. Demetrius, Julius Cæſar, Caligula, and Nero, made ſeveral unſucceſsful efforts to open this paſſage. But, as the ancients were entirely ignorant of the uſe of water-locks, their whole attention was employed in making level cuts, which is probably the principal reaſon why they ſo often failed in their attempts. Charlemagne formed a deſign of joining the Rhine and the Danube, in order to make a communication between the ocean and the Black ſea, by a canal from the river Almutz which diſcharges itſelf into the Danube, to the Reditz, which falls into the Main, and this laſt falls into the Rhine near Mayence; for this purpoſe he employed a prodigious number of workmen; but he met with ſo many obſtacles from different quarters, that he was obliged to give up the attempt.

The French at preſent have many fine canals: that of Briare was begun under Henry IV. and finiſhed under the direction of Cardinal Richelieu in the reign of Louis XIII. This canal makes a communication betwixt the Loire and the Seine by the river Loing. It extends 11 French great leagues from Briare to Montargis. It enters the Loire a little above Briare, and terminates in the Loing at Cepoi. There are 42 locks on this canal.

The canal of Orleans, for making another communication between the Seine and the Loire, was begun in 1675, and finiſhed by Philip of Orleans, regent of France, during the minority of Louis XV. and is furniſhed with 20 locks. It goes by the name of the *canal of Orleans*; but it begins at the village of Combleux, which is a ſhort French league from the town of Orleans.

But the greateſt and moſt uſeful work of this kind is the junction of the ocean with the Mediterranean by the canal of Languedoc. It was propoſed in the reigns of Francis I. and Henry IV. and was undertaken and finiſhed under Louis XIV. It begins with a large reſervoir 4000 paces in circumference, and 24 feet deep, which receives many ſprings from the mountain Noire. This canal is about 64 leagues in length, is ſupplied by a number of rivulets, and is furniſhed with 104 locks, of about eight feet riſe each. In ſome places it paſſes over bridges of vaſt height; and in others it cuts through ſolid rocks for 1000 paces. At one end it joins the river Garonne near Thoulouſe, and terminates at the other in the lake Tau, which extends to the port of Cette. It was planned by Francis Riquet in the 1666, and finiſhed before his death, which happened in the 1680.

In the Dutch, Auſtrian, and French Netherlands, there is a very great number of canals; that from Bruges to Oſtend carries veſſels of 200 tons.

The Chineſe have alſo a great number of canals; that which runs from Canton to Pekin extends about 825 miles in length, and was executed about 800 years ago.

It would be an endleſs taſk to deſcribe the numberleſs canals in Holland, Ruſſia, Germany, &c. We ſhall therefore confine ourſelves to ſome of the more important in our own country.

As the promoting of commerce is the principal intention of making canals, it is natural to expect that their frequency in any nation ſhould bear ſome proportion to the trade carried on in it, providing the ſituation of the country will admit of them. The preſent ſtate of England and Scotland confirms this obſervation. Though the Romans made a canal between the Nyne, a little below Peterborough, and the Witham, three miles below Lincoln, which is now almoſt entirely filled up, yet it is not long ſince canals were revived in England. They are now however become very numerous, particularly in the counties of York, Lincoln, and Cheſhire. Moſt of the counties betwixt the mouth of the Thames and the Briſtol channel are connected together either by natural or artificial navigations; thoſe upon the Thames and Iſis reaching within about 20 miles of thoſe upon the Severn. The duke of Bridgewater's canal in Cheſhire runs 27 miles on a perfect level; but at Barton it is carried by a very high aqueduct bridge over the Irwell, a navigable river; ſo that it is common for veſſels to be paſſing at the ſame time both under and above the bridge. It is likewiſe cut ſome miles into the hills, where the duke's coal-mines are wrought.

A navigable canal betwixt the Forth and Clyde in Scotland, and which divides the kingdom in two parts, was firſt thought of by Charles II. for tranſports and ſmall ſhips of war; the expence of which was to have been 500,000l. a ſum far beyond the abilities of his reign. It was again projected in the year 1722, and a ſurvey made; but nothing more done till 1761, when the then Lord Napier, at his own expence, cauſed a ſurvey, plan, and eſtimate on a ſmall ſcale to be made. In 1764, the truſtees for fiſheries, &c. in Scotland cauſed make another ſurvey, plan, and eſtimate of a canal five feet deep, which was to coſt 79,000l. In 1766, a ſubſcription was obtained by a number of the moſt reſpectable merchants in Glaſgow, for making a canal four feet deep and twenty-four feet in breadth; but when the bill was nearly obtained in parliament, it was given up on account of the ſmallneſs of the ſcale, and a new ſubſcription ſet on foot for a canal ſeven feet deep, eſtimated at 150,000l. This obtained the ſanction of parliament; and the work was begun in 1768 by Mr Smeaton the engineer. The extreme length of the canal from the Forth to the Clyde is 35 miles, beginning at the mouth of the Carron, and ending at Dalmuir Burnfoot on the Clyde, ſix miles below Glaſgow, riſing and falling 160 feet by means of 39 locks, 20 on the eaſt ſide of the ſummit, and 19 on the weſt, as the tide does not ebb ſo low in Clyde as in the Forth by nine feet. Veſſels drawing eight feet water, and not exceeding nineteen feet beam and ſeventy-three feet in length, paſs with eaſe, the canal having afterwards been deepened to upwards of eight feet. The whole enterpriſe diſplays the art of man in a high degree. The carrying the canal through moſs, quickſand, gravel and rocks, up precipices and over valleys, was attended with inconceivable difficulties. There are eighteen draw-bridges and fifteen aqueduct bridges of note, beſides ſmall ones and tunnels. In the firſt three miles there are only ſix locks; but in the fourth mile there are no leſs than ten locks, and a very fine aqueduct bridge over the great road to the weſt of Falkirk. In the next ſix miles there are only four locks which carry you to the ſummit. The canal then runs eighteen miles on a level, and terminates by one branch about a mile from Glaſgow. In this courſe, for a conſiderable way, the ground is banked about twenty feet high, and the water is ſixteen feet deep, and two miles of it is made through a deep moſs. At Kirkintilloch, the canal is carried over the water of Logie on an aqueduct arch of ninety feet broad. This arch was thrown over in three ſtretches, having only a centre of thirty feet, which was ſhifted on ſmall rollers from one ſtretch to another; a thing new, and never attempted before with an arch of this ſize; yet the joinings are as fairly equal as any other part, and admired as a very fine piece of maſonry. On each ſide there is a very conſiderable banking over the valley. This work was carried on till it came with ſix miles of its junction with the Clyde; when the ſubſcription and a ſubſequent loan being exhauſted, the work was ſtopt in 1775. The city of Glaſgow however, by means of a collateral branch, opened a communication with the Forth, which has produced a revenue of about 6000l. annually; and, in order to finiſh the remaining ſix miles, the government in 1784 gave 50,000l. out of the forfeited eſtates, the dividends ariſing from this ſum to be applied to making and repairing roads in the Highlands of Scotland. The work was accordingly reſumed; and by contract, under a high penalty, was to be entirely completed in November 1789. The aqueduct bridge over the Kelvin, which is ſuppoſed the greateſt of the kind in the world, conſiſts of four arches, and carries the canal over a valley 65 feet high, and 420 in length, exhibiting a very ſingular effort of human ingenuity and labour. To ſupply the canal with water was of itſelf a very great work. There is one reſervoir of 50 acres 24 feet deep, and another of 70 acres 22 feet deep, into which many rivers and ſprings terminate, which it is thought will afford a ſufficient ſupply of water at all times. This whole undertaking when finiſhed coſt about 200,000l. It is the greateſt of the kind in Britain, and of great national utility; though it is to be regretted that it had not been executed on a ſtill larger ſcale, the locks being too ſhort for tranſporting large maſts.

This canal was completed in July 1790. On the 28th of this month, a track barge belonging to the company of proprietors ſailed from the baſon, near the city of Glaſgow, to Bowling bay, where the canal joins the river Clyde. The committee of management, accompanied by the magiſtrates of Glaſgow, were the firſt voyagers on the new canal. On the arrival of the veſſel at Bowling bay, after deſcending from the laſt lock into the Clyde, the ceremony of the junction of the Forth and Clyde was performed by the chairman of the committee, who, with the aſſiſtance of the chief engineer, diſcharged into the river Clyde, a hogſhead of water taken up from the river Forth, as a ſymbol of joining the weſtern and eaſtern ſeas together.

About the year 1801, a canal was finiſhed between Loch Gilp to Loch Crinan in Argyleſhire. The diſtance is about nine miles. This canal, which is called the Crinan canal, is intended to accommodate the trade of the Weſtern Iſlands and fiſheries. The veſſels employed in this trade will, by means of this canal, avoid the circuitous and dangerous navigation round the Mull of Cantire.

Another canal was begun laſt year (1803), which intended to open a communication between the Weſtern ſea, and the Murray frith, by the locks or arms of the ſea, which ſtretch inland on the weſt ſide, and by Loch Neſs on the eaſt.

Canal, in *Anatomy*, a duct or paſſage through which any of the juices flow.

CANANOR, a large maritime town of Aſia, on the coaſt of Malabar, in a kingdom of the ſame name, with a very large and ſafe harbour. It formerly belonged to the Portugueſe, and had a ſtrong fort to guard it; but in 1683, the Dutch, together with the natives, drove them away; and after they became maſters of the town, enlarged the fortifications. They have but a very ſmall trade; but there is a town at the bottom of the bay, independent of the Dutch, whoſe prince can bring 20,000 men into the field. The Dutch fort is large, and the governor's lodgings are at a good diſtance from the gate; ſo that, when there was a ſkirmiſh between the factory and the natives, he knew nothing of it till it was over. E. Long. 78. 10. N. Lat. 12. 0.

Cananor, a ſmall kingdom of Aſia, on the coaſt of Malabar, whoſe king can raiſe a conſiderable army. The natives are generally Mahometans; and the country produces pepper, cardamoms, ginger, mirobolans, and tamarinds, in which they drive a conſiderable trade.

CANARA, a kingdom of Aſia, on the coaſt of Malabar. The inhabitants are Gentoos, or Pagans; and there is a pagod or temple, called *Ramtrut*, which is viſited every year by a great number of pilgrims. Here the cuſtom of burning the wives with their huſbands had its beginning, and is practiſed to this day. The country is generally governed by a woman, who keeps her court at a town called *Baydor*, two days journey from the ſea. She may marry whom ſhe pleaſes; and is not obliged to burn with her huſband, like her female ſubjects. They are ſo good obſervers of their laws, that a robbery or murder is ſcarce ever heard of among them. The Canarans have forts built of earth along the coaſt, which are garriſoned with 200 or 300 ſoldiers, to guard againſt the robberies of their neighbours. The lower grounds yield every year two crops of corn or rice; and the higher produce pepper, betelnuts, ſanders wood, iron, and ſteel. The Portugueſe clergy here live very looſely, and make no ſcruple of procuring women for ſtrangers.

CANARIA, in *Ancient Geography*, one of the Fortunate Iſlands, a proof that theſe were what are now called the *Canaries*. Canaria had its name from its abounding with dogs of an enormous ſize, two of which were brought to Juba king of Mauritania. See the following article.

Canaria, or the *Grand Canary*, an iſland in the Atlantic ocean, about 180 miles from the coaſt of Africa. It is about 100 miles in circumference, and 33 in diameter. It is a fruitful iſland, and famous for the wine that bears its name. It alſo abounds with apples, melons, oranges, citrons, pomegranates, figs, olives, peaches, and plantains. The fir and palm trees are the moſt common. The towns are, Canary the capital, Gualdera, and Geria.

CANARY, or Cividad de Palmas, is the capital of the iſland of Canaria, with an indifferent caſtle, and a biſhop's ſee. It has alſo a court of inquiſition, and the ſupreme council of the reſt of the Canary iſlands; as alſo four convents, two for men and two for women. The town is about three miles in compaſs, and contains 12,000 inhabitants. The houſes are only one ſtory high, and flat at the top; but they are well built. The cathedral is a handſome ſtructure. W. Long. 15. 20. N. Lat. 28. 4.

CANARY *Iſlands*, are ſituated in the Atlantic ocean, over againſt the empire of Morocco in Africa. They were formerly called the *Fortunate Iſlands*, on account of the temperate healthy air, and excellent fruits. The land is very fruitful, for both wheat and barley produce 130 for one. The cattle thrive well, and the woods are full of all ſorts of game. The Canary ſinging birds are well known all over Europe. There are here ſugar-canes in great abundance; but the Spaniards firſt planted vines here, from whence we have the wine called *Canary* or *Sack*.

Theſe iſlands were not entirely unknown to the ancients; but they were a long while forgot, till John de Betencourt diſcovered them in 1402. It is ſaid they were firſt inhabited by the Phœnicians, or Carthaginians, but on no certain foundation; nor could the inhabitants themſelves tell from whence they were derived; on the contrary, they did not know there was any other country in the world. Their language, manners, and cuſtoms, had no reſemblance to thoſe of their neighbours. However, they were like the people on the coaſt of Barbary in complexion. They had no iron. After the diſcovery, the Spaniards ſoon got poſſeſſion of them all, under whoſe dominion they are to this day, except Madeira, which belongs to the Portugueſe. The inhabitants are chiefly Spaniards; though there are ſome of the firſt people remaining, whom they call *Guanches*, who are ſomewhat civilized by their intercourſe with the Spaniards. They are a hardy, active, bold people, and live on the mountains. Their chief food is goat's milk. Their complexion is tawny, and their noſes flat. The Spaniſh veſſels, when they ſail for the Weſt Indies, always rendezvous at theſe iſlands, going and coming. Their number is 12. 1. Alegranza; 2. Canaria; 3. Ferro; 4. Fuerteventura; 5. Gomera; 6. Gratioſa; 7. Lancerotta; 8. Madeira; 9. Palma: 10. Rocca; 11. Salvages; 12. Teneriff. Weſt longitude from 12 to 21. north latitude from 27. 30. to 29. 50.

CANARY-*Bird*. See FRINGILLA. Theſe birds are much admired for their ſinging, and take their name from the place from whence they originally came, viz. the Canary-iſlands; but of late years there is a ſort of birds brought from Germany, and eſpecially from Tirol, and therefore called *German birds*, which are much better than the others; though both are ſuppoſed to have originally come from the ſame place. The cocks never grow fat, and by ſome country people cannot be diſtinguiſhed from common green-birds; though the Canary-birds are much luſtier, have a longer tail, and differ much in the heaving of the paſſages of the throat when they ſing. Theſe birds being ſo much eſteemed for their ſong, are ſometimes ſold at a high price, according to the goodneſs and excellency of their notes; ſo that it will always be adviſable to hear one ſing before he is bought. In order to know whether he is in good health, take him out of the ſtore-cage, and put him in a clean cage by himſelf; if he ſtand up boldly, without crouching or ſhrinking in his feathers, look with a briſk eye, and is not ſubject to clap his head under his wing, it is a ſign that he is in good health; but the greateſt matter is to obſerve his dunging: if he bolts his tail like a nightingale after he has dunged, it is a ſign he is not in good health, or at leaſt that he will ſoon be ſick; but if his dung be very thin like water, or of a ſlimy white without any blackneſs in it, it is a ſign of approaching death. When in perfect health, his dung lies round and hard, with a fine white on the outſide, dark within, and dries quickly; though a ſeed-bird ſeldom dungs ſo hard, unleſs he is very young.

Canary-birds are ſubject to many diſeaſes, particularly impoſthumes which affect the head, cauſe them to fall ſuddenly from the perch, and die in a ſhort time, if not ſpeedily cured. The moſt approved medicine is an ointment made of freſh butter and capon's greaſe melted together. With this the top of the bird's head is to be anointed for two or three days, and it will diſſolve the impoſthume: but if the medicine has been too long delayed, then, after three or four times anointing, ſee whether the place of his head be ſoft; and if ſo, open it gently, and let out the matter, which will be like the yolk of an egg; when this is done, anoint the place, and the bird will be cured. At the ſame time he muſt have figs with his other food, and in his water a ſlice or two of liquorice, with white ſugar-candy.

Canary-birds are diſtinguiſhed by different names at different times and ages: ſuch as are about three years old are called *runts*; thoſe above two are named *eriſſs*; thoſe of the firſt year under the care of the old ones, are termed *branchers*; thoſe that are new-flown, and cannot feed themſelves, *puſhers*; and thoſe brought up by hand, *neſtlings*.

The Canary-birds may be bred with us; and, if treated with proper care, they will become as vigorous and healthful as in the country from whence they have their name. The cages in which theſe birds are kept are to be made either of walnut-tree or oak, with bars of wire; becauſe theſe, being woods of ſtrength, do not require to be uſed in large pieces. The common ſhape of cages, which is cylindric, is very improper for theſe birds; for this allows little room to walk, and without that the birds uſually become melancholy. The moſt proper of all ſhapes is the high and long, but narrow.

If theſe birds eat too much, they grow over-fat, loſe their ſhape, and their ſinging is ſpoiled; or at leaſt they become ſo idle, that they will ſcarce ever ſing. In this caſe their victuals are to be given them in a much ſmaller quantity, and they will by this means be recovered by degrees to all their beauty, and will ſing as at firſt.

At the time that they are about to build their neſts, there muſt be put into their cages ſome hay, dried thoroughly in the ſun: with this muſt be mixed ſome moſs dried in the ſame manner, and ſome ſtag's hair; and great care is to be taken of breeding the young, in the article of food. As ſoon as the young birds are eight days old, or ſomewhat more, and are able to eat and pick up food of themſelves, they are to be taken out of the cage in which they were hatched, and each put ſeparately into another cage, and hung up in a room where it may never have an opportunity of hearing the voice of any other bird. After they have been kept thus about eight days, they are to be excited to ſing by a bird-pipe; but this is not to be blowed too much, or in too ſhrill a manner, leſt they ſing themſelves to death.

For the firſt fifteen days the cages are to be covered with a black cloth, and for the fifteen days following with a green one. Five leſſons in a day from the pipe are ſufficient for theſe young creatures; and they muſt not be diſturbed with ſeveral ſounds at the ſame time, leſt they confound and puzzle them: two leſſons ſhould be given them early in the morning, one about the middle of the day, and two or more at night.

The genius and temper of the ſeveral birds of this kind are very different. The males are almoſt always melancholy, and will not ſing unleſs they are excited to it by hearing others continually ſinging about them. The male bird of this kind will often kill the female put to him for breeding; and when there are ſeveral females together with the males, they will often do the ſame to one another from jealouſy. It is therefore not eaſy to manage the article of their breeding well in this particular, unleſs in this manner: let two female birds be put into one cage, and when they have lived together ſome time, they will have contracted a ſort of love for one another, which will not eaſily be diſſolved. Put a male bird into the cage with theſe two, and every thing will go well; their friendſhip will keep them from quarrelling about his favours, and from danger of his miſchievous diſpoſition; for if he attacks one of them, in order to kill her, the other will immediately take her part; and after a few of theſe battles, the male will find that they are together an overmatch for him at fighting, and will then diſtribute his favours to them, and there will not fail of being a young breed or two, which are to be taken away from their parents, and educated as before directed. Some males watch the time of the female's laying, and devour the eggs as faſt as ſhe depoſits them; and others take the young ones in their beak as ſoon as hatched, and cruſh them to death againſt the ſides of the cage, or ſome other way deſtroy them. When a male has been known once to have been guilty of this, he is to be ſhut up in a ſmall cage, in the middle of the large one in which the female is breeding her young, and thus he will often comfort her with ſinging all day long, while ſhe ſits upon the eggs or takes care of the young ones; and when the time of taking away, to put them into ſeparate cages, is come, the male is to be let out, and he will always after this live in friendſhip with the female.

If the male become ſick during the time of the female's ſitting or bringing up her young, he muſt be removed immediately, and only brought to the ſide of her cage at certain times, that ſhe may ſee him, till he is perfectly cured; and then he is to be ſhut up again in his cage in the middle.

Canary-birds are various in their notes; ſome having a ſweet ſong, others a lowiſh note, others a long ſong, which is beſt, as having the greateſt variety of notes; but they ſing chiefly either the titlark or nightingale notes. See *Song of Birds*.

CANCALLE, a town of France, in Upper Brittany, by the ſea-ſide, where there is a road. Here the Britiſh landed in 1758, in their way to St Maloes, where they burnt a great number of ſhips in the harbour, and then retired without loſs. This town was in their power; but they acted like generous enemies, and did no hurt to this nor any other on the coaſt. W. Long. 0. 13. N. Lat. 48. 41.

CANCELIER, in falconry, is when a light brown hawk, in her ſtooping, turns two or three times upon the wing, to recover herſelf before ſhe ſeizes.

CANCELLI, a term uſed to denote lattice windows, or thoſe made of croſs bars diſpoſed latticewiſe; it is alſo uſed for rails or balluſters incloſing the communion-table, a court of juſtice, or the like, and for the network in the inſide of hollow bones.

CANCELLING, in the civil law, an act whereby a perſon conſents that ſome former deed be rendered null and void. This is otherwiſe called *reſciſion*. The word comes from the Latin *cancellare*, to encompaſs or pale a thing round. In the proper ſenſe of the word, *to cancel*, is to deface an obligation, by paſſing the pen from top to bottom, or acroſs it; which makes a kind of chequer lattice, which the Latins call *cancelli*.

CANCER, in *Zoology*, a genus of inſects belonging to the order of inſecta aptera. This genus includes the lobſter, the crab, the prawn, the ſhrimp, and the crawfiſh. See Entomology *Index*.

Cancer, in *Medicine*, a roundiſh, unequal, hard, and livid tumour, generally ſeated in the glandulous parts of the body, ſuppoſed to be ſo called, becauſe it appears at length with turgid veins ſhooting out from it, ſo as to reſemble, as it is thought, the figure of a crab-fiſh, or others ſay, becauſe, like that fiſh, where it has once got, it is ſcarce poſſible to drive it away. See Medicine *Index*.

Cancer, in *Aſtronomy*, one of the twelve ſigns, repreſented on the globe in the form of a crab, and thus marked (♋) in books. It is the fourth conſtellation in the ſtarry zodiac, and that from which one quadrant of the ecliptic takes its denomination. The reaſon generally aſſigned for its name as well as figure, is a ſuppoſed reſemblance which the ſun's motion in this ſign bears to the crab-fiſh. As the latter walks backwards, ſo the former, in this part of his courſe, begins to go backwards, or recede from us: though the diſpoſition of ſtars in this ſign is by others ſuppoſed to have given the firſt hint to the repreſentation of a crab.

Tropic of Cancer, in *Aſtronomy*, a leſſer circle of the ſphere parallel to the equator, and paſſing through the beginning of the ſign Cancer.

CANCHERIZANTE, or Cancherizato, in the Italian muſic, a term ſignifying a piece of muſic that begins at the end, being the retrograde motion from the end of a ſong, &c. to the beginning.

CANCROMA, or Boat-bill. See Ornithology *Index*.

CANDAHAR, a province of Perſia, bounded on the north by the province of Balk; on the eaſt, by that of Cabul; on the ſouth, by Buchor and Sableſtan; and on the weſt, by Sigeſtan. There have been bloody wars between the Indians and Perſians on account of this province; but in 1650 it fell to the Perſians. The inhabitants are known by the name of *Agkuans*, or *Affghans*, who have often endeavoured to throw off the yoke. But, in 1707, they were ſeverely puniſhed for ſuch an attempt. See Persia.

Candahar, the capital of the above province, is ſeated on a mountain; and being a place of great trade, has a conſiderable fortreſs. The caravans that travel from Perſia and the parts about the Caſpian ſea to the Eaſt Indies, chooſe to paſs through Candahar, becauſe there is no danger of being robbed on this road, and proviſions are very reaſonable. The religion is Mahometaniſm, but there are many Banians and Guebres. E. Long. 67. 5. N. Lat. 33. 0.

CANDAULES, the laſt king of Lydia, of the family of the Heraclides. See LYDIA.

CANDELARES, (from *candela*, a candle), the name of an order in the former editions of Linnæus's Fragments of a natural method, conſiſting of theſe three genera, *rhizophora*, *nyſſa* and *mimuſops*. They are removed, in the latter editions, into the order HOLORACEÆ.

CANDIA, the modern name of the iſland of Crete (ſee Crete). The word is a variation of *Khunda*, which was originally the Arabian name of the metropolis only, but in time came to be applied to the whole iſland.

Candia came into the poſſeſſion of the Venetians, by purchaſe, in the year 1194, as related under the article CRETE; and ſoon began to flouriſh under the laws of that wiſe republic. The inhabitants, living under the protection of a moderate government, and being encouraged by their maſters, engaged in commerce and agriculture. The Venetian commandants readily afforded to thoſe travellers who viſited the iſland, that aſſiſtance which is neceſſary to enable them to extend and improve uſeful knowledge. Belon, the naturaliſt, is laviſh in praiſe of their good offices, and deſcribes, in an intereſting manner, the flouriſhing ſtate of that part of the iſland which he viſited.

The ſeat of government was eſtabliſhed at Candia. The magiſtrates and officers, who compoſed the council, reſided there. The proviſor-general was preſident. He poſſeſſed the chief authority; and his power extended over the whole principality. It continued in the poſſeſſion of the Venetians for five centuries and a half Cornaro held the chief command at the time when it was threatened with a ſtorm, on the ſide of Conſtantinople. The Turks, for the ſpace of a year, had been employed in preparing a vaſt armament. They deceived the Venetian, by aſſuring him that it was intended againſt Malta. In the year 1645, in the midſt of a ſolemn peace, they appeared unexpectedly before Crete with a fleet of 400 ſail, having on board 60,000 land forces, under the command of four pachas. The emperor Ibrahim, under whom this expedition was undertaken, had no fair pretext to offer in juſtification of his enterprize. He made uſe of all that perfidy which characteriſes the people of the eaſt, to impoſe on the Venetian ſenate. He loaded their ambaſſador with preſents, directed his fleet to bear for Cape Matapan, as if they had been going beyond the Archipelago; and cauſed the governors of Tina and Cerigna to be ſolemnly aſſured that the republic had nothing to fear for her poſſeſſions. At the very inſtant when he was making thoſe aſſurances, his naval armament entered the gulf of Canea; and, paſſing between that city and St Theodore, anchored at the mouth of Platania.

The Venetians, not expecting this ſudden attack, had made no preparations to repel it. The Turks landed without oppoſition. The iſle of St Theodore is but a league and an half from Canea. It is only three quarters of a league in compaſs. The Venetians had erected two forts there; one of which, ſtanding on the ſummit of the higheſt eminence, on the coaſt of that little iſle, was called Turluru; the other, on a lower ſituation, was named St Theodore. It was an important object to the Muſſulmans to make themſelves maſters of that rock, which might annoy their ſhips. They immediately attacked it with ardour. The firſt of thoſe fortreſſes, being deſtitute of ſoldiers and cannon, was taken without ſtriking a blow. The garriſon of the other conſiſted of no more than 60 men. They made a gallant defence, and ſtood out till the laſt extremity; and when the Turks at laſt prevailed, their number was diminiſhed to ten, whom the captain-pacha cruelly cauſed to be beheaded.

Being now maſters of that important poſt, as well as of Lazaret, an elevated rock, ſtanding about half a league from Canea, the Turks inveſted the city by ſea and land. General Cornaro was ſtruck, as with a thunder-clap, when he learned the deſcent of the enemy. In the whole iſland there were no more than a body of 3500 infantry, and a ſmall number of cavalry. The beſieged city was defended only by 1000 regular troops, and a few citizens, who were able to bear arms. He made haſte to give the republic notice of his diſtreſs; and poſted himſelf off the road, that he might the more readily ſuccour the beſieged city. He threw a body of 250 men into the town before the lines of the enemy were completed. He afterwards made ſeveral attempts to ſtrengthen the beſieged with other reinforcements; but in vain. The Turks had advanced in bodies cloſe to the town, had carried a half-moon battery, which covered the gate of Retimo; and were battering the walls night and day with their numerous artillery. The beſieged defended themſelves with reſolute valour, and the ſmalleſt advantage which the beſiegers gained coſt them dear. General Cornaro made an attempt to arm the Greeks, particularly the Spachiots, who boaſted loudly of their valour. He formed a battalion of theſe. But the æra of their valour was long paſt. When they beheld the enemy, and heard the thunder of the cannon, they took to flight; not one of them would ſtand fire.

When the ſenate of Venice were deliberating on the means to be uſed for relieving Canea, and endeavouring to equip a fleet, the Mahometan generals were ſacrificing the lives of their ſoldiers to bring their enterpriſe to a glorious termination. In different engagements they had already loſt 20,000 warriors; but, deſcending into the ditches, they had undermined the walls, and blown up the moſt impregnable forts with exploſions of powder. They ſprung one of thoſe mines beneath the baſtion of St Demetri. It overturned a conſiderable part of the wall, which cruſhed all the defenders of the baſtion. That inſtant the beſiegers ſprung up with their ſabres in their hands, and taking advantage of the general conſternation of the beſieged on that quarter, made themſelves maſters of the poſt. The beſieged, recovering from their terror, attacked them with unequalled intrepidity. About 400 men aſſailed 2000 Turks already firmly poſted on the wall, and preſſed upon them with ſuch obſtinate and dauntleſs valour, that they killed a great number, and drove the reſt down into the ditch. In this extremity, every perſon in the city was in arms. The Greek monks took up muſkets; and the women, forgetting the delicacy of their ſex, appeared on the walls among the defenders, either ſupplying the men with ammunition and arms, or fighting themſelves; and ſeveral of thoſe daring heroines loſt their lives.

For 50 days the city held out againſt all the forces of the Turks. If, even at the end of that time, the Venetians had ſent a naval armament to its relief, the kingdom of Candia might have been ſaved. Doubtleſs, they were not ignorant of this well-known fact. The north wind blows ſtraight into the harbour of Canea. When it blows a little briſkly, the ſea rages. It is then impoſſible for any ſquadron of ſhips, however numerous, to form in line of battle in the harbour, and to meet an enemy. If the Venetians had ſet out from Cerigo with a fair wind, they might have reached Canea in five hours, and might have entered the harbour with full ſails, without being expoſed to one cannon-ſhot; while none of the Turkiſh ſhips would have dared to appear before them; or if they had ventured, muſt have been driven back on the ſhore, and daſhed in pieces among the rocks. But, inſtead of thus taking advantage of the natural circumſtances of the place, they ſent a few galleys, which, not daring to double Cape Spada, coaſted along the ſouthern ſhore of the iſland, and failed of accompliſhing the deſign of their expedition.

At laſt, the Caneans, deſpairing of relief from Venice, ſeeing three breaches made in their walls, through which the infidels might eaſily advance upon them, exhauſted with fatigue, and covered with wounds, and reduced to the number of 500 men, who were obliged to ſcatter themſelves round the walls, which were half a league in extent, and undermined in all quarters, demanded a parley, and offered to capitulate. They obtained very honourable conditions; and after a glorious defence of two months, which coaſt the Turks 20,000 men, marched out of the city with the honours of war. Thoſe citizens who did not chooſe to continue in the city, were permitted to remove; and the Ottomans, contrary to their uſual practice, faithfully obſerved their ſtipulations.

The Venetians, after the loſs of Canea, retired to Retimo. The captain-pacha laid ſiege to the citadel of the Sude, ſituated in the entrance of the bay, on a high rock, of about a quarter of a league in circumference. He raiſed earthen-batteries, and made an ineffectual attempt to level the ramparts. At laſt, deſpairing of taking it by aſſault, he left ſome forces to block it up from all communication, and advanced towards Retimo. That city, being unwalled, was defended by a citadel, ſtanding on an eminence which overlooks the harbour. General Cornaro had retired thither. At the approach of the enemy, he advanced from the city, and waited for them in the open field. In the action, inattentive to his own ſafety, he encouraged the ſoldiers, by fighting in the ranks. A glorious death was the reward of his valour; but his fall determined the fate of Retimo.

The Turks having landed additional forces on the iſland, they introduced the plague, which was almoſt a conſtant attendant on their armies. This dreadful peſt rapidly advanced, and. like a devouring fire, waſting all before it, deſtroyed moſt part of the inhabitants. The reſt, flying in terror before its ravages, eſcaped into the Venetian territories, and the iſland was left almoſt deſolate.

The ſiege of the capital commenced in 1646, and was protracted much longer than that of Troy. Till the year 1648, the Turks ſcarce gained any advantages before that city. They were often routed by the Venetians, and ſometimes compelled to retire to Retimo. At that period Ibrahim was ſolemnly depoſed, and his eldeſt ſon, at the age of nine years, was raiſed to the throne, under the name of Mahomet IV. Not ſatisfied with confining the ſultan to the horrors and obſcurity of a dungeon, the partizans of his ſon ſtrangled him on the 19th of Auguſt, in the ſame year. That young prince, who mounted the throne by the death of his father, was afterwards expelled from it, and condemned to paſs the remainder of his life in confinement.

In the year 1649, Uſſein Pacha, who blockaded Candia, receiving no ſupplies from the Porte, was compelled to raiſe the ſiege, and retreat to Canea. The Venetians were then on the ſea with a ſtrong ſquadron. They attacked the Turkiſh fleet in the bay of Smyrna, burnt 12 of their ſhips and two gallies, and killed 6000 of their men. Some time after, the Mahometans having found means to land an army on Candia, renewed the ſiege of the city with greater vigour, and made themſelves maſters of an advanced fort that was very troubleſome to the beſieged; which obliged them to blow it up.

From the year 1650 till 1658, the Venetians, continuing maſters of the ſea, intercepted the Ottomans every year in the ſtraits of the Dardanelles, and fought them in four naval engagements; in which they defeated their numerous fleets, ſunk a number of their caravels, took others, and extended the terror of their arms even to the walls of Conſtantinople. That capital became a ſcene of tumult and diſorder. The Grand Signior, alarmed, and trembling for his ſafety, left the city with precipitation.

Such glorious ſucceſs revived the hopes of the Venetians, and depreſſed the courage of the Turks. They converted the ſiege of Candia into a blockade, and ſuffered conſiderable loſſes. The ſultan, in order to exclude the Venetian fleet from the Dardanelles, and to open to his own navy a free and ſafe paſſage, cauſed two fortreſſes to be built at the entrance of the ſtraits. He gave orders to the pacha of Canea to appear again before the walls of Candia, and to make every poſſible effort to gain the city. In the mean time, the republic of Venice, to improve the advantages which they had gained, made ſeveral attempts on Canea. In 1660, that city was about to ſurrender to their arms, when the pacha of Rhodes, haſtening to its relief, reinforced the defenders with a body of 2000 men. He happily doubled the extremity of Cape Melec, though within ſight of the Venetian fleet, which was becalmed off Cape Spada, and could not advance one fathom to oppoſe an enemy conſiderably weaker than themſelves.

Kiopruli, ſon and ſucceſſor to the viſir of that name, who had long been the ſupport of the Ottoman empire, knowing that the murmurs of the people againſt the long continuance of the ſiege of Candia were riſing to a height, and fearing a general revolt, which would be fatal to himſelf and his maſter, ſet out from Byzantium about the end of the year 1666 at the head of a formidable army. Having eſcaped the Venetian fleet, which was lying off Canea with a view to intercept him, he landed at *Palio Castro*, and formed his lines around Candia. Under his command were four pachas, and the flower of the Ottoman forces. Thoſe troops, being encouraged by the preſence and the promiſes of their chiefs, and ſupported by a great quantity of artillery, performed prodigies of valour. All the exterior forts were deſtroyed. Nothing now remained to the beſieged but the bare line of the walls, unprotected by fortreſſes; and theſe being battered by an inceſſant diſcharge of artillery, ſoon gave way on all quarters. Still, however, what poſterity may perhaps regard as incredible, the Caneans held out three years againſt all the force of the Ottoman empire. At laſt they were going to capitulate, when the hope of aſſiſtance from France reanimated their valour, and rendered them invincible. The expected ſuccours arrived on the 26th of June 1669. They were conducted by the duke of Noailles. Under his command were a great number of French noblemen, who came to make trial of their ſkill in arms againſt the Turks.

Next day after their arrival, the ardour of the French prompted them to make a general ſally. The duke of Beaufort, admiral of France, aſſumed the command of the forlorn hope. He was the firſt to advance againſt the Muſſulmans, and was followed by a numerous body of infantry and cavalry. They advanced furiouſly upon the enemy, attacked them within their trenches, forced the trenches, and would have compelled them to abandon their lines and artillery, had not an unforeſeen accident damped their courage. In the midſt of the engagement a magazine of powder was ſet on fire; the foremoſt of the combatants loſt their lives; the French ranks were broken; ſeveral of their leaders, among whom was the duke of Beaufort, diſappeared for ever; the ſoldiers fled in diſorder; and the duke of Noailles, with difficulty, effected a retreat within the walls of Candia. The French accuſed the Italians of having betrayed them; and on that pretext prepared to ſet off ſooner than the time agreed upon. No entreaties of the commandant could prevail with them to delay their departure; ſo they reimbarked. Their departure determined the fate of the city. There were now no more than five hundred men to defend it. Moroſini capitulated with Kiopruli, to whom he ſurrendered the kingdom of Crete, excepting only the Sude, Grabuſa, and Spina-Longua. The grand-viſir made his entrance into Candia on the 4th of October 1670, and ſtaid eight months in that city, inſpecting the reparation of its walls and fortreſſes.

The three fortreſſes left in the hands of the Venetians by the treaty of capitulation remained long after in their poſſeſſion. At laſt they were all taken, one after another. In ſhort, after a war of 30 years continuance, in the courſe of which more than 200,000 men fell in the iſland, and it was deluged with ſtreams of Chriſtian and Mahometan blood, Candia was entirely ſubdued by the Turks, in whoſe hands it ſtill continues.

Of the climate of Candia travellers ſpeak with rapture. The heat is never exceſſive; and in the plains violent cold is never felt. In the warmeſt days of ſummer the atmoſphere is cooled by breezes from the ſea. Winter properly begins here with December and ends with January; and during that ſhort period ſnow never falls on the lower grounds, and the ſurface of the water is rarely frozen over. Moſt frequently the weather is as fine then as it is in Britain at the beginning of June. Theſe two months have received the name of *winter*, becauſe in them there is a copious fall of rain, the ſky is obſcured with clouds, and the north winds blow violently; but the rains are favourable to agriculture, the winds chaſe the clouds towards the ſummits of the mountains, where a repoſitory is formed for thoſe waters which are to fertilize the fields; and the inhabitants of the plain ſuffer no inconvenience from theſe tranſient blaſts. In the month of February, the ground is overſpread with flowers and riſing crops. The reſt of the year is almoſt one continued fine day. The inhabitants of Crete never experience any of thoſe mortifying returns of piercing cold, which are ſo frequently felt in Britain and even more ſouthern countries; and which, ſucceeding ſuddenly after the cheriſhing heats of ſpring, nip the bloſſoming flowers, wither the open buds, deſtroy half the fruits of the year, and are fatal to delicate conſtitutions. The ſky is always unclouded and ſerene; the winds are mild and refreſhing breezes. The radiant ſun proceeds in ſmiling majeſty along the azure vault, and ripens the fruits on the lofty mountains, the riſing hills, and the plains. The nights are no leſs beautiful: their coolneſs is delicious. The atmoſphere not being overloaded with vapours, the ſky unfolds to the obſerver's view a countleſs profuſion of ſtars; thoſe numerous ſtars ſparkle with the moſt vivid rays, and ſtrew the azure vault in which they appear fixed, with gold, with diamonds, and with rubies. Nothing can be more magnificent than this ſight, and the Cretans enjoy it for ſix months in the year.

To the charms of the climate other advantages are joined which augment their value: There are ſcarce any moraſſes in the iſland; the waters here are never in a ſtate of ſtagnation; they flow in numberleſs ſtreams from the tops of the mountains, and form here and there large fountains or ſmall rivers that empty themſelves into the ſea; the elevated ſituation of their ſprings cauſes them to daſh down with ſuch rapidity, that they never loſe themſelves in pools or lakes; conſequently inſects cannot depoſit their eggs upon them, as they would be immediately hurried down into the ſea; and Crete is not infeſted like Egypt with thoſe clouds of inſects which ſwarm in the houſes, and whoſe ſting is inſufferably painful; nor is the atmoſphere here loaded with thoſe noxious vapours which riſe from marſhy grounds.

The mountains and hills are overſpread with various kinds of thyme, ſavoury, wild thyme, and with a multitude of odoriferous and balſamic plants; the rivulets which flow down the vallies are overhung with myrtles, laurel, and roſes; clumps of orange, citron, and almond trees, are plentifully ſcattered over the fields; the gardens are adorned with tufts of Arabian jaſmine. In ſpring, they are beſtrewed with beds of violets; ſome extenſive plains are arrayed in ſaffron; the cavities of the rocks are fringed with ſweet ſmelling dittany. In a word, from the hills, the vales, and the plains, on all hands, there ariſe clouds of exquiſite perfumes, which embalm the air, and render it a luxury to breathe it.

As to the inhabitants, the Mahometan men are generally from five feet and a half to ſix feet tall. They bear a ſtrong reſemblance to ancient ſtatues; and it muſt have been after ſuch models that the ancient artiſts wrought. The women alſo are generally beautiful. Their dreſs does not reſtrain the growth of any part of their bodies, and their ſhape therefore aſſumes thoſe admirable proportions with which the hand of the Creator has graced his faireſt workmanſhip on earth. They are not all handſome or charming; but ſome of them are beautiful, particularly the Turkiſh ladies. In general, the Cretan women have a riſing throat, a neck gracefully rounded, black eyes ſparkling with animation, a ſmall mouth, a fine noſe, and cheeks delicately coloured with the freſh vermilion of health. But the oval of their form is different from that of Europeans, and the character of their beauty is peculiar to their own nation.

The quadrupeds belonging to the iſland are not of a ferocious temper. There are no lions, tigers, bears, wolves, foxes, or indeed any dangerous animal here. Wild goats are the only inhabitants of the foreſts that overſpread the lofty mountains, and theſe have nothing to fear but the ball of the hunter; hares inhabit the hills and the plain; ſheep graze in ſecurity on the thyme and the heath; they are folded every night, and the ſhepherd ſleeps ſoundly without being diſturbed with the fear that wild animals may invade and ravage his folds.

The Cretans are very happy in not being expoſed to the troubleſome bite of noxious inſects, the poiſon of ſerpents, or the rapacity of the wild beaſts of the deſert. The ancients believed that the iſland enjoyed theſe ſingular advantages, on account of its having been the birth-place of Jupiter. "The Cretans (ſays Ælian) celebrate in their ſongs the beneficence of Jupiter, and the favour which he conferred on their iſland, which was the place of his birth and education, by freeing it from every noxious animal, and even rendering it unfit for nouriſhing thoſe noxious animals that are introduced into it from foreign countries.

Dittany holds the firſt rank among the medicinal plants which are produced in Crete. The praiſes beſtowed on the virtues of this plant by the ancients are altogether extravagant; yet we perhaps treat the medicinal virtues of this plant with two much contempt. Its leaf is very balſamic, and its flower diffuſes around it a delicious odour. At preſent the inhabitants of the iſland apply it with ſucceſs on various occaſions. The leaf, when dried and taken in an infuſion with a little ſugar, makes a very pleaſant drink, of a finer flavour than tea. It is there an immediate cure for a weak ſtomach, and enables it to recover its tone after a bad digeſtion.

Diſeaſes are very rare in a country whoſe atmoſphere is exceedingly pure; and in Candia, epidemical diſeaſes are unknown. Fevers prevail here in ſummer, but are not dangerous; and the plague would be wholly unknown, had not the Turks deſtroyed the lazarets that were eſtabliſhed by the Venetians, for ſtrangers to do quarantine in. Since the period when theſe were demoliſhed, it is occaſionally introduced by ſhips from Smyrna and Conſtantinople. As no precautions are taken againſt it, it gains ground, and ſpreads over the iſland from one province to another; and as the colds and heats are never intemperate, it ſometimes continues its ravages for ſix months at a time.

This fine country is infeſted with a diſeaſe ſomewhat leſs dangerous than the plague, but whoſe ſymptoms are ſomewhat more hideous; that diſeaſe is the leproſy. In ancient times, Syria was the focus in which it raged with moſt fury: and from Syria it was carried into ſeveral of the iſlands of the Archipelago. It is infectious, and is inſtantaneouſly communicated by contact. The victims who are attacked by it, are driven from ſociety, and confined to little ruinous houſes on the high way. They are ſtrictly forbidden to leave theſe miſerable dwellings, or hold intercourſe with any perſon. Thoſe poor wretches have generally beſide their huts a ſmall garden producing pulſe, and feeding poultry; and with that ſupport, and what they obtain from paſſengers, they find means to drag out a painful life in circumſtances of ſhocking bodily diſtreſs. Their bloated ſkin is covered with a ſcaly cruſt, ſpeckled with red and white ſpots; which afflict them with intolerable itchings. A hoarſe and tremulous voice iſſues from the bottom of their breaſts. Their words are ſcarce articulated; becauſe their diſtemper inwardly preys upon the organs of ſpeech. Theſe frightful ſpectres gradually loſe the uſe of their limbs. They continue to breathe till ſuch time as the whole maſs of their blood is corrupted, and their bodies entirely in a ſtate of putrefaction: The rich are not attacked by this diſtemper: it confines itſelf to the poor, chiefly to the Greeks. But thoſe Greeks obſerve ſtrictly their four lents; aud eat nothing during that time but ſalt fiſh, botorgo ſalted and ſmoked, pickled olives, and cheeſe. They drink plentifully of the hot and muddy wines of the iſland. The natural tendency of ſuch a regimen muſt be, to fire the blood, to thicken the fluid part of it, and thus at length to bring on a leproſy.

Candia is at preſent governed by three pachas, who reſide reſpectively at Candia, Canea, and Retimo. The firſt, who is always a pacha of three tails, may be conſidered as viceroy of the iſland. He enjoys more extenſive powers than the others. To him the inſpection of the forts and arſenals is entruſted. He nominates to ſuch military employments as fall vacant, as well as to the governments of the Sude, Grabuſa, Spina Longua, and Gira-petra. The governors of theſe forts are denominated *beys*. Each of them has a conſtable and three general officers under him: one of whom is commander of the artillery; another of the cavalry; and the third of the juniſſaries.

The council of the pacha conſiſts of a kyaia, who is the channel through which all orders are iſſued, and all favours beſtowed; an aga of the janiſſaries, colonel-general of the troops, who has the chief care of the regulation of the police; two topigi bachi; a defterdar, who is treaſurer-general for the imperial revenues; a keeper of the imperial treaſury; and the chief officers of the army. This government is entirely military, and the power of the pacha ſeraſquier is abſolute. The juſtice of his ſentences is never called in queſtion; they are inſtantly carried into execution.

Candia.

The people of the law, are the mufti, who is the religious head, and the cadi. The firſt interprets thoſe laws which regard the diviſion of the patrimony among the children of a family, ſucceſſions, and marriages,---in a word, all that are contained in the Koran; and he alſo decides on every thing that relates to the ceremonies of the Muſſalman religion. The cadi cannot pronounce ſentence on affairs connected with theſe laws, without firſt taking the opinion of the mufti in writing, which is named *Faitfa.* It is his buſineſs to receive the declarations, complaints, and donations of private perſons; and to decide on ſuch differences as ariſe among them. The pacha is obliged to conſult thoſe judges when he puts a Turk legally to death; but the pacha, who is dignified with three tails, ſets himſelf above all laws, condems to death, and ſees his ſentence executed, of his own proper authority. All the moſques have their itam, a kind of curate, whoſe duty is to perform the ſervice. There are ſchoolmaſters in the different quarters of the city. Theſe perſons are much reſpected in Turkey, and are honoured with the title of *effendi.*

The garriſon of Candia conſiſts of 46 companies, compoſing a military force of about ten thouſand men. All theſe forces do not reſide conſtantly in the city, but they may be muſtered in a very ſhort time. They are all regularly paid every three months, excepting the janiſſaries, none of whom but the officers receive pay. The different gradations of this military body do not depend on the pacha. The council of each company, conſiſting of veterans, and of officers in actual ſervice, has the power of naming to them. A perſon can occupy the ſame poſt for no longer than two years; but the poſt of *sorbagi*, or captain, which is purchaſed at Conſtantinople, is held for life. The *ousta*, or cook, is alſo continued in his employment as long as the company to which he belongs is ſatisfied with him. Each company has its almoner, denominated *imam.*

The garriſons of Canea and Retimo, formed on a ſimilar plan, are much leſs numerous. The firſt conſiſts of about 3000 men, the other of 500; but as all the male children of the Turks are enrolled among the janiſſaries as ſoon as born, the number of theſe troops might be greatly augmented in time of war; but, to ſay the truth, they are far from formidable. Moſt of them have never ſeen fire, nor are they ever exerciſed in military evolutions.

The pachas of Canea and Retimo are no leſs abſolute, within the bounds of their reſpective provinces, than the pacha of Candia. They enjoy the ſame privileges with him, and their council conſiſts of the ſame officers. Theſe governors chief object is to get rich as ſpeedily as poſſible; and in order to accompliſh that end, they practiſe all the arts and cruelties of oppreſſion, to ſqueeze money from the Greeks. In truth, thoſe poor wretches run to meet the chains with which they are loaded. Envy, which always preys upon them, continually prompts them to take up arms. If ſome one among them happen to enjoy a decent fortune, the reſt aſſiduouſly ſeek ſome pretence for accuſing him before the pacha, who takes advantage of theſe diſſentions, to ſeize the property of both the parties. It is by no means aſtoniſhing, that under ſo barbarous a government, the number of the Greeks is daily diminiſhed.

Candia.

There are ſcarcely	150,000 Greeks
in the iſland, 65,000 of whom pay the carach. The Turks have not poſſeſſed the iſland for more than 120 years; yet, as they are not expoſed to the ſame oppreſſion, they have multiplied in it, and raiſed themſelves upon the ruin of the ancient inhabitants. The number amounts to	200,000 Turks.
The Jews, of whom there are not many in the iſland, amount only to	200
Total is	350,200 ſouls.

This fertile country is in want of nothing but induſtrious huſbandmen, ſecure of enjoying the fruit of their labours. It might maintain four times its preſent number of inhabitants.

Antiquity has celebrated the iſland of Crete as containing 100 populous cities; and the induſtry of geographers has preſerved their names and ſituations. Many of theſe cities contained no fewer than 30,000 inhabitants;---and by reckoning them, on an average, at 6000 each, we ſhall in all probability be rather within than beyond the truth. This calculation gives

for 100 cities	600,000
By allowing the ſame number as inhabitants of the towns, villages, and all the reſt of the iſland,	600,000
the whole number of the inhabitants of ancient Crete will amount to	1,200,000

This number cannot be exaggerated. When Candia was in the hands of the Venetians, it was reckoned to contain nine hundred fourſcore and ſixteen villages.

It appears, therefore, that when the iſland of Crete enjoyed the bleſſing of liberty, it maintained to the number of 849,800 more inhabitants than it does at preſent. But ſince thoſe happier times, ſhe has been deprived of her laws by the tyranny of the Romans; has groaned under the deſtructive ſway of the monarchs of the lower empire; has been expoſed for a period of 120 years to the ravages of the Arabians; has next paſſed under the dominion of the Venetians; and has at laſt been ſubjected to the deſpotiſm of the Turks, who have produced a dreadful depopulation in all the countries which have been ſubdued by their arms.

The Turks allow the Greeks the free exerciſe of their religion, but forbid them to repair their churches or monaſteries; and accordingly they cannot obtain permiſſion to repair their places of worſhip, or religious houſes, but by the powerful influence of gold. From this article the pachas derive very conſiderable ſums. They have 12 biſhops as formerly, the firſt of whom aſſumes the title of archbiſhop of Gortynia. He reſides at Candia; in which city the metropolitan church of the iſland ſtands. He is appointed by the patriarch of Conſtantinople; and has the right of nominating to all the other biſhoprics of the iſland; the names of which are, Gortynia, Cnoſſou, Mirabella, Hyera, Gira-petra, Arcadia, Cherroneſe, Lambis, Milopotamo, Retimo, Canea, Ciſamo. Theſe biſhoprics are nearly the ſame as under the reign of the Greek emperors.

The patriarch wears a triple tiara, writes his ſignature in red ink, and anſwers for all the debts of the clergy. To enable him to fulfil his engagements, he lays impoſitions on the reſt of the biſhops, and particularly on the monaſteries, from which he draws very handſome contributions. He is conſidered as the head of the Greeks, whom he protects, as far as his ſlender credit goes. The orders of government are directed to him on important occaſions; and he is the only one of all the Greeks in the iſland who enjoys the privilege of entering the city on horſeback.

CANDIA, is the capital of the above iſland, ſituated on its northern coaſt, in E. Long. 25. 0. N. Lat. 35. 30. It ſtands on the ſame ſituation which was formerly occupied by Heraclea, and is the ſeat of government under the Turks. Its walls, which are more than a league in compaſs, are in good repair, and defended by deep ditches, but not protected by any exterior fort. Towards the ſea, it has no attacks to fear; becauſe the ſhallowneſs of the harbour renders it inacceſſible to ſhips of war.

The Porte generally commits the government of this iſland to a pacha of three tails. The principal officers, and ſeveral bodies of the Ottoman ſoldiery, are ſtationed here. This city, when under the Venetians, was opulent, commercial, and populous; but it has now loſt much of its former ſtrength and grandeur. The harbour, naturally a fine baſon, in which ſhips were ſecurely ſheltered from every ſtorm, is every day becoming narrower and ſhallower. At preſent it admits only boats, and ſmall ſhips after they have diſcharged a part of their freight. Thoſe veſſels, which the Turks freight at Candia, are obliged to go almoſt empty to the port of Standie, whither their cargoes are conveyed to them in barks. Such inconveniences are highly unfavourable to commerce; and as government never thinks of removing them, the trade of Candia is therefore conſiderably decayed.

Candia, which was embelliſhed by the Venetians with regular ſtreets, handſome houſes, a fine ſquare, and a magnificent ciſtern, contains at preſent but a ſmall number of inhabitants, notwithſtanding the vaſt extent of the area encloſed within its walls. Several diviſions of the city are void of inhabitants. That in which the market-place ſtands is the only one which diſcovers any ſtir of buſineſs, or ſhow of affluence. The Mahometans have converted moſt of the Chriſtian temples into moſques; yet they have left two churches to the Greeks, one to the Armenians, and a ſynagogue to the Jews. The Capuchins poſſeſs a ſmall convent, with a chapel in which the vice-conſul of France hears maſs. At preſent he is the only Frenchman who attends it, as the French merchants have taken up their reſidence at Canea.

Weſt of the city of Candia is an extenſive range of hills, which are a continuation of Mount Ida, and of which the extremity forms the promontory of Dion. On the way to Dion, we find Palio Caſtro, on the ſhore; a name which the modern Greeks give indifferently to all remains of ancient cities. Its ſituation correſponds to that of the ancient Panormus, which ſtood north-weſt from Heraclea.

The river which runs weſt of Candia was anciently known by the name of Triton; near the ſource of which Minerva ſprung from the brain of Jove. Loaxus is a little farther diſtant. About a league eaſt of that city, the river Ceratus flows through a delightful vale. According to Strabo, in one part of its courſe it runs near by Gnoſſus. A little beyond that, is another river ſuppoſed to be Therenus, on the banks of which, fable relates that Jupiter conſummated his marriage with Juno. For the ſpace of more than half a league round the walls of Candia there is not a ſingle tree to be ſeen. The Turks cut them all down in the time of the ſiege, and laid waſte the gardens and orchards. Beyond that extent, the country is plentifully covered with corn and fruit trees. The neighbouring hills are overſpread with vineyards, which produce the malmſey of Mound Ida,---worthy of preference at the table of the moſt exquiſite connoiſſeur in wines. That ſpecies of wine, though little known, has a fine flavour, a very pleaſant reliſh, and is highly eſteemed in the iſland.

CANDIAC, JOHN LEWIS, a premature genius, born at Candiac in the dioceſe of Niſmes in France, in 1719. In the cradle he diſtinguiſhed his letters: at 13 months, he knew them perfectly: at three years of age, he read Latin, either printed or in manuſcript: at four, he tranſlated from that tongue: at ſix, he read Greek and Hebrew; was maſter of the principles of arithmetic, hiſtory, geography, heraldry, and the ſcience of medals; and had read the beſt authors on almoſt every branch of literature. He died of a complication of diſorders, at Paris, in 1726.

CANDIDATE, a perſon who aſpires to ſome public office.

In the Roman commonwealth, they were obliged to wear a white gown during the two years of their ſoliciting a place. This garment, according to Plutarch, they wore without any other clothes, that the people might not ſuſpect they concealed money for purchaſing votes, and alſo that they might more eaſily ſhow to the people the ſcars of thoſe wounds they had received in fighting for the defence of the commonwealth. The candidates uſually declared their pretenſions a year before the time of election, which they ſpent in making intereſt and gaining friends. Various arts of popularity were practiſed for this purpoſe, and frequent circuits made round the city, and viſits and compliments to all ſorts of perſons, the proceſs of which was called *ambitus*. See AMBITUS.

CANDIDATI MILITES, an order of ſoldiers, among the Romans, who ſerved as the emperor's body-guards to defend him in battle. They were the talleſt and ſtrongeſt of the whole troops, and moſt proper to inſpire terror. They were called *candidati*, becauſe clothed in white, either that they might be more conſpicuous, or becauſe they were conſidered in the way of preferment.

CANDISH, a conſiderable province of Aſia, in the dominions of the Great Mogul, bounded by Chytor and Malvo on the north, Orixa on the eaſt, Decan on the ſouth, and Guzerat on the weſt. It is populous and rich; and abounds in cotton, rice, and indigo. Brampore is the capital town.

CANDLE, a ſmall taper of tallow, wax, or ſpermaceti; the wick of which is commonly of ſeveral threads of cotton, ſpun and twiſted together.

A tallow-candle, to be good, muſt be half ſheep's and half bullocks tallow; for hog's tallow makes the candle gutter, and always gives an offenſive ſmell, with a thick black ſmoke. The wick ought to be pure, ſufficiently dry, and properly twiſted; otherwiſe the candle will emit an inconſtant vibratory flame, which is both prejudicial to the eyes, and inſufficient for the diſtinct illumination of objects.

There are two ſorts of tallow-candles; the one dipped, the other moulded: the former are the common candles; the others are the invention of the ſieur le Brege at Paris.

As to the method of making candles in general: After the tallow has been weighed, and mixed in the due proportions, it is cut into very ſmall pieces, that it may melt the ſooner; for the tallow in lumps, as it comes from the butchers, would be in danger of burning or turning black, if it were left too long over the fire. Being perfectly melted and ſkimmed, they pour a certain quantity of water into it, proportionable to the quantity of tallow. This ſerves to precipitate to the bottom of the veſſel the impurities of the tallow which may have eſcaped the ſkimmer. No water, however, muſt be thrown into the tallow deſigned for the three firſt dips; becauſe the wick, being ſtill quite dry, would imbibe the water, which makes the candles crackle in burning, and renders them of bad uſe. The tallow, thus melted, is poured into a tub, through a coarſe ſieve of horſe-hair, to purify it ſtill more, and may be uſed after having ſtood three hours. It will continue fit for uſe 24 hours in ſummer and 15 in winter. The wicks are made of ſpun cotton, which the tallow-chandlers buy in ſkains, and which they wind up into bottoms or clues; whence they are cut out, with an inſtrument contrived on purpoſe, into pieces of the length of the candle required; then put on the ſticks or broaches, or elſe placed in the moulds, as the candles are intended to be either dipped or moulded.

Wax-candles are made of a cotton or flaxen wick, ſlightly twiſted, and covered with white or yellow wax. Of theſe, there are ſeveral kinds: ſome of a conical figure, uſed to illuminate churches, and in proceſſions, funeral ceremonies, &c. (ſee Taper); others of a cylindrical form, uſed on ordinary occaſions. The firſt are either made with a ladle or the hand. 1. To make wax-candles with the ladle. The wicks being prepared, a dozen of them are tied by the neck, at equal diſtances, round an iron circle, ſuſpended over a large baſon of copper tinned, and full of melted wax: a large ladle full of this wax is poured gently on the tops of the wicks one after another, and this operation continued till the candle arrive at its deſtined bigneſs; with this precaution, that the three firſt ladles be poured on at the top of the wick, the fourth at the height of $\frac{3}{4}$, the fifth at $\frac{1}{2}$, and the ſixth at $\frac{1}{4}$, in order to give the candle its pyramidal form. Then the candles are taken down, kept warm, and rolled and ſmoothed upon a walnut-tree table, with a long ſquare inſtrument of box, ſmooth at the bottom. 2. As to the manner of making wax-candles by the hand, they begin to ſoften the wax, by working it ſeveral times in hot water, contained in a narrow but deep caldron. A piece of the wax is then taken out, and diſpoſed by little and little around the wick, which is hung on a hook in the wall, by the extremity oppoſite to the neck; ſo that they begin with the big end, diminiſhing ſtill as they deſcend towards the neck. In other reſpects the method is nearly the ſame as in the former caſe. However, it muſt be obſerved, that, in the former caſe, water is always uſed to moiſten the ſeveral inſtruments, to prevent the wax from ſticking; and in the latter, oil of olives, or lard, for the hands, &c. The cylindrical wax-candles are either made as the former, with a ladle, or drawn. Wax-candles drawn, are ſo called, becauſe actually drawn in the manner of wire, by means of two large rollers of wood, turned by a handle, which, turning backwards and forwards ſeveral times, paſs the wick through melted wax contained in a braſs baſon, and at the ſame time through the holes of an inſtrument like that uſed for drawing wire faſtened at one ſide of the baſon.

If any chandlers mix with their wares any thing deceitfully, &c. the candles ſhall be forfeited, by ſtat. 23 Eliz.; and a tax or duty is granted on candles, by 8 and 9 Anne, cap. 6. made for ſale, of one penny a pound, beſides the duty upon tallow, by 8 Anne, cap. 9. And by 24 Geo. III. cap. 11. an additional duty of a halfpenny a pound: and, by the ſame an additional duty of a halfpenny a pound is laid upon all candles imported (except thoſe of wax and ſpermaceti, for which ſee Wax *Candles*), ſubject alſo to the two additional 5 per cents. impoſed by 19 and 22 Geo. III. beſides the duty of $2\frac{1}{4}$d. formerly impoſed by 2 W. ſeſſ. 2. cap. 4. 8. Anne, cap. 9. and 9 Anne, cap. 6. And every maker of candles, other than wax candles, for ſale, ſhall annually take out a licenſe at 1l. The maker of candles ſhall, in four weeks within the bills, and elſewhere in ſix weeks, after entry, clear off the duties on pain of double duty: nor ſell any after default in payment on pain of double value; 8 Anne, cap. 9. The makers of candles are not to uſe melting houſes, without making a true entry, on pain of 100l. and to give notice of making candles to the exciſe officer for the duties; and of the number, &c. or ſhall forfeit 50l. ſtat. 11. Geo. I. cap. 30. See alſo 23 Geo. II. cap. 21. and 26 Geo. II. cap. 32. No maker of candles for ſale ſhall begin to make candles, without notice firſt given to the officers, unleſs from September 29th to March 25th yearly, between ſeven in the morning and five in the evening, and from March 25th to September 29th, between five in the morning and ſeven in the evening, on pain of 10l. 10 Anne, cap. 26. The penalty of obſtructing the officer is 20l. and of removing candles before they are ſurveyed 20l. 8 Anne, cap. 9. The penalty of privately making candles is the forfeiture of the ſame and utenſils, and 100l. 5 Geo. III. cap. 43. And the penalty of mingling weighed with unweighed candles, of removing them before they are weighed, or of concealing them, is the forfeiture of 100l. 11 Geo. cap. 30. Candles, for which the duty hath been paid, may be exported, and the duty drawn back; but no draw-back ſhall be allowed on the exportation of any foreign candles imported. 8 Ann. cap. 9. 23 Geo. II. cap. 21.

The Roman candles were at firſt little ſtrings dipt in pitch, or ſurrounded with wax; though afterwards they made them of the papyrus, covered likewiſe with wax; and ſometimes alſo of ruſhes, by ſtripping off the outer rind, and only retaining the pith.---For religious offices, wax candles were uſed; for vulgar uſes, thoſe of tallow. Lord Bacon propoſes candles of divers compoſitions and ingredients, as alſo of different ſorts of wicks; with experiments of the degrees of duration, and light of each. Good houſewives bury their candles in flour or bran, which it is ſaid increaſes their laſting almoſt half.

Experiments to determine the real and comparative value of burning Candles *of different ſorts and ſizes.*

	Numb of candles in one pound.	Weight of one candle.		The time one candle laſted		The time that one pound will laſt.		The expence in 12 hours when candles are at 6d per dozen, which alſo shows the proportion of the expence at any price per dozen.
		Oz.	Dr.	Hr.	Min.	Hr.	Min.	Farthings and 100th parts.
Small wick.	$18\frac{1}{3}$	0	14	3	15	59	26	4.85
Large wick.	19	0	$13\frac{1}{2}$	2	40	50	34	5.70
	$16\frac{1}{2}$	0	$15\frac{1}{2}$	2	40	44	2	6.54
	12	1	$5\frac{1}{3}$	3	27	41	24	6.96
*	$10\frac{3}{4}$	1	8	3	36	38	24	7.50
*	$7\frac{3}{4}$	2	1	4	9	32	12	8.94
*	8	2	0	4	15	34	0	8.47
	$5\frac{3}{4}$	2	13	5	19	30	15	9.53
	Mould. candles							Mould - candl. at 7s. per doz.
	$5\frac{7}{8}$	2	12	7	20	42	39	7.87
	4	4	0	9	3	36	20	9.28

N. B. The time one candle laſted was taken from an average of ſeveral trials in each ſize.

It is obſervable, in optics, that the flame of two candles joined, gives a much ſtronger light than both of them ſeparate. The obſervation was ſuggeſted by Dr Franklin. Probably the union of the two flames produces a greater degree of heat, whereby the vapour is attenuated, and the particles of which light conſiſts are more copiouſly emitted.

Mr Nicholſon has made ſome intereſting obſervations on the light afforded by lamps and candles, which we ſhall lay before our readers in his own words †. "We are acquainted with no means, (ſays he), unleſs we may except electricity, of producing light but by combuſtion, and this is moſt probably of the ſame nature. The rude method of illumination conſiſts in ſucceſſively burning certain maſſes of fuel in the ſolid ſtate. Common fires anſwer this purpoſe in the apartments of houſes, and in ſome light-houſes: ſmall pieces of reſinous wood, and the bituminous coal called *kannel-coal*, are in ſome countries applied to the ſame uſe; but the moſt general and uſeful method is that in which fat oil, of an animal or vegetable kind, is burned by means of a wick. Theſe inſtruments of illumination are either lamps or candles. In the lamp, the oil muſt be one of thoſe which retains its fluidity in the ordinary temperature of the atmoſphere. The candle is formed of an oil, or other material, which is not fuſible but at a temperature conſiderably elevated.

"The method of meaſuring the comparative intenſities of light is one of the firſt requiſites in an inquiry concerning the art of illumination. Two methods of conſiderable accuracy are deſcribed in the *Traité d'Optique* of Bouguer, of which an abridged account is given by Dr Prieſtley in his Optics. The firſt of theſe two methods has been uſed by others ſince that time, and probably before, from its very obvious nature, but particularly by Count Rumford, who has given a deſcription and drawings of an inſtrument called the *photometer*, in the Philoſophical Tranſactions for 1794. The principle it is grounded upon is, that if two lights ſhine upon the ſame ſurface at equal obliquities, and an opake body be interpoſed, the two ſhadows it will produce muſt differ in blackneſs or intenſity in the ſame degree. For the ſhadow formed by intercepting the greater light will be illuminated by the ſmaller light only, and reverſely the other ſhadow will be illuminated by the greater light. That is to ſay, in ſhort, the ſtronger light will be attended with a deeper ſhadow. But it is eaſy, by removing the greater light to a greater diſtance, to render the illumination it produces at the common ſurface equal to that afforded by the leſs. Experiments of this kind may be conveniently made by faſtening a ſheet of white paper againſt the wall of a room. The two lights or candles intended to be compared, muſt then be placed ſo that the ray of light from each ſhall fall with nearly the ſame angle of incidence upon the middle of the paper. By ſome experiments made in this way in the year 1785, I was ſatisfied that the degree of illumination could be thus aſcertained to the 80th or 90th part of the whole.

"By experiments of this kind many uſeful particulars may be ſhewn. Thus, for example, the light of a candle, which is ſo exceedingly brilliant when firſt ſnuffed, is very ſpeedily diminiſhed to one-half, and is uſually not more than one-fifth or one-ſixth before the uneaſineſs of the eye induces us to ſnuff it. Whence it follows, that if candles could be made ſo as not to require ſnuffing, the average quantity of light afforded by the ſame quantity of combuſtible matter would be more than doubled. In the ſame way, likewiſe, ſince the coſt and duration of candles, and the conſumption of oil in lamps, are eaſily aſcertainable, it may be ſhewn whether more or leſs of light is obtained at the ſame expence during a given time, by burning a number of ſmall candles inſtead of one of greater thickneſs. From a few experiments already made out of the numerous and uſeful ſeries that preſents itſelf, I have reaſon to think that there is very much waſte in this expenſive article of accommodation.

"In the lamp there are three articles which demand our attention, the oil, the wick, and the ſupply of air. It is required that the oil ſhould be readily inflammable, without containing any fetid ſubſtance which may prove offenſive, or mucilage, or other matter, to obſtruct the channels of the wick. I do not know of any proceſs for meliorating oils for this purpoſe, excepting that of waſhing with water containing acid or alkali. Either of theſe is ſaid to render the mucilage of animal oils more ſoluble in the water; but acid is preferred, becauſe it is leſs diſpoſed to combine with the oil itſelf. The office of the wick appears to be chiefly, if not ſolely, to convey the oil by capillary attraction to the place of combuſtion. As the oil is conſumed and flies off, other oil ſucceeds, and in this way a continued current of oil and maintenance of the flame are effected. But as the wicks of lamps are commonly formed of combuſtible matter, it appears to be of ſome conſequence what the nature and ſtructure of this material may be. It is certain that the flame afforded by a wick of ruſh differs very conſiderably from that afforded by cotton; though perhaps this difference may, in a great meaſure, depend on the relative dimenſions of each. And if we may judge from the different odour in blowing out a candle of each ſort, there is ſome reaſon to ſuſpect that the decompoſition of the oil is not effected preciſely in the ſame manner in each. We have alſo ſome obſcure accounts of prepared wicks for lamps, which are ſtated to poſſeſs the property of facilitating the combuſtion of very impure oils, ſo that they ſhall burn for many hours without ſmoke or ſmell.

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† Philoſoph. Jour. vol. i.

“ The acceſs of air is of the laſt importance in every proceſs of combuſtion. When a lamp is fitted up with a very ſlender wick, the flame is ſmall, and of a brilliant white colour: if the wick be larger, the combuſtion is leſs perfect, and the flame is brown: a ſtill larger wick not only exhibits a brown flame, but the lower internal part appears dark, and is occupied by a portion of volatilized matter, which does not become ignited until it has aſcended towards the point. When the wick is either very large or very long, part of this matter eſcapes combuſtion, and ſhews itſelf in the form of coal or ſmoke. The different intenſity of the ignition of flame, according to the greater or leſs ſupply of air, is remarkably ſeen by placing a lamp with a ſmall wick beneath a ſhade of glaſs not perfectly cloſed below, and more or leſs covered above. While the current of air through the glaſs ſhade is perfectly free, the flame is white; but in proportion as the aperture above is diminiſhed, the flame becomes brown, long, wavering, and ſmoky; it inſtantly recovers its original whiteneſs when the opening is again enlarged. The inconvenience of a thick wick has been long ſince obſerved, and attempts made to remove it: in ſome inſtances by ſubſtituting a number of ſmall wicks inſtead of a larger; and in others, by making the wick flat inſtead of cylindrical. The moſt ſcientific improvement of this kind, though perhaps leſs ſimple than the ordinary purpoſes of life demand, is the well-known lamp of Argand. In this the wick forms a hollow cylinder or tube, which ſlides over another tube of metal, ſo as to afford an adjuſtment with regard to its length. When this wick is lighted, the flame itſelf has the figure of a thin tube, to the inner as well as the outer ſurface of which the air has acceſs from below. And a cylindrical ſhade of glaſs ſerves to keep the flame ſteady, and in a certain degree to accelerate the current of air. In this very ingenious apparatus many experiments may be made with the greateſt facility. The inconvenience of a long wick, which ſupplies more oil than the volume of flame is capable of burning, and which conſequently emits ſmoke, is ſeen at once by raiſing the wick; and, on the other hand, the effect of a ſhort wick, which affords a diminutive flame merely for want of a ſufficient ſupply of combuſtible matter, is obſervable by the contrary proceſs.

“ The moſt obvious inconvenience of lamps in general, ariſes from the fluidity of the combuſtible material, which requires a veſſel adapted to contain it, and even in the beſt conſtructed lamps is more or leſs liable to be ſpilled. When the wick of a lamp is once adjuſted as to its length, the flame continues nearly in the ſame ſtate for a very conſiderable time.

“ It is almoſt unneceſſary to deſcribe a thing ſo univerſally known as a candle. This article is formed of a conſiſtent oil, which envelopes a porous wick of fibrous vegetable matter. The cylindrical form and dimenſions of the oil are given either by caſting it in a mould, or by repeatedly dipping the wick into the fuſed ingredient. Upon comparing a candle with a lamp, two very remarkable particulars are immediately ſeen. In the firſt place, the tallow itſelf, which remains in the refuſed ſtate, affords a cup or cavity to hold that portion of melted tallow which is ready to flow into the lighted part of the wick. In the ſecond place, the combuſtion, inſtead of being confined, as in the lamp, to a certain determinate portion of the fibrous matter, is carried, by a ſlow ſucceſſion, through the whole length. Hence ariſes the greater neceſſity for frequent ſnuffing the candle; and hence alſo the ſtation of the freezing point of the fat oil becomes of great conſequence. For it has been ſhown that the brilliancy of the flame depends very much on the diameter of the wick being as ſmall as poſſible; and this requiſite will be moſt attainable in candles formed of a material that requires a higher degree of heat to fuſe it. The wick of a tallow candle muſt be made thicker in proportion to the greater fuſibility of the material, which would otherwiſe melt the ſides of the cup, and run over in ſtreams. The flame will therefore be yellow, ſmoky, and obſcure, excepting for a ſhort time immediately after ſnuffing. Tallow melts at the 92d degree of Fahrenheit's thermometer; ſpermaceti at the 133d degree: the fatty matter formed of fleſh after long immerſion in water melts at 127°; the *pela* of the Chineſe, at 145°; bees-wax at 142°; and bleached wax at 155°. Two of theſe materials are well known in the fabrication of candles. Wax in particular does not afford ſo brilliant a flame as tallow: but, on account of its fuſibility, the wick can be made ſmaller; which not only affords the advantage of a clear perfect flame, but from its flexibility it is diſpoſed to turn on one ſide, and come in contact with the external air, which completely burns the extremity of the wick to white aſhes, and thus performs the office of ſnuffing. We ſee, therefore, that the important object to ſociety of rendering tallow candles equal to thoſe of wax, does not at all depend on the combuſtibility of the reſpective materials, but upon a mechanical advantage in the cup, which is afforded by the inferior degree of fuſibility in the wax; and that, to obtain this valuable object, one of the following effects muſt be produced: Either the tallow muſt be burned in a lamp, to avoid the gradual progreſſion of the flame along the wick; or ſome means muſt be deviſed to enable the candle to ſnuff itſelf, as the wax candle does; or, laſtly, the tallow itſelf muſt be rendered leſs fuſible by ſome chemical proceſs. I have no great reaſon to boaſt of ſucceſs in the endeavour to effect theſe; but my hope is, that the facts and obſervations here preſented may conſiderably abridge the labour of others in the ſame purſuit.

“ The makers of thermometers and other ſmall articles with the blow-pipe and lamp, give the preference to tallow inſtead of oil, becauſe its combuſtion is more complete, and does not blacken the glaſs. In this operation, the heat of the lamp melts the tallow which is occaſionally brought into its vicinity by the workman. But for the uſual purpoſes of illumination, it cannot be ſuppoſed that a perſon can attend to ſupply the combuſtible matter. Conſiderable difficulties ariſe in the project for affording this gradual ſupply as it may be wanted. A cylindrical piece of tallow was inſerted into a metallic tube, the upper aperture of which was partly cloſed by a ring, and the central part occupied by a metallic piece nearly reſembling that part of the common lamp which carries the wick. In this appartus the piece laſt deſcribed was intended to anſwer the ſame purpoſe, and was provided with a ſhort wick. The cylinder of tallow was ſupported beneath in ſuch a manner that the metallic tube and other part of this lamp were left to reſt with their whole weight upon the tallow at the ring or contraction of the upper aperture. In this ſituation the lamp was lighted. It burned for ſome time with a very bright clear flame, which, when compared with that of a candle, poſſeſſed the advantages of uniform intenſity, and was much ſuperior to the ordinary flame of a lamp in its colour, and the perfect abſence of ſmell. After ſome minutes it began to decay, and very ſoon afterwards went out. Upon examination it was found, that the metallic piece which carried the wick had fuſed a ſufficient quantity of tallow for the ſupply during the combuſtion; that part of this tallow had flowed beneath the ring, and to other remote parts of the apparatus, beyond the influence of the flame; in conſequence of which, the tube and the cylinder of tallow were faſtened together, and the expected progreſſion of ſupply prevented. It ſeems probable, that in every lamp for burning conſiſtent oils, the material ought to be ſo diſpoſed that it may deſcend to the flame upon the principle of the fountain reſervoir. I ſhall not here ſtate the obſtacles which preſent themſelves in the proſpect of this conſtruction, but ſhall diſmiſs the ſubject by remarking, that a contrivance of this nature would be of the greateſt public utility.

“ The wick of a candle, being ſurrounded by the flame, is nearly in the ſituation of a body expoſed to deſtructive diſtillation in a cloſe veſſel. After loſing its volatile products, the carbonaceous reſidue retains its figure, until, by the deſcent of the flame, the external air can have acceſs to its upper extremity. But, in this caſe, the requiſite combuſtion, which might ſnuff it, is not effected. For the portion of oil emitted by the long wick is not only too large to be perfectly burned, but alſo carries off much of the heat of the flame while it aſſumes the elaſtic ſtate. By this diminiſhed combuſtion and increaſed efflux of half-decompoſed oil, a portion of coal or ſoot is depoſited on the upper part of the wick, which gradually accumulates, and at length aſſumes the appearance of a fungus. The candle does not then give more than one-tenth of the light emitted in its beſt ſtate. Hence it is that a candle of tallow cannot ſpontaneouſly ſnuff itſelf. It was not probable that the addition of a ſubſtance containing vital air or oxygen would ſupply that principle at the preciſe period of time required; but, as experiment is the teſt of every probability of this nature, I ſoaked a wick of cotton in a ſolution of nitre, then dried it, and made a candle. When this came to be lighted, nothing remarkable happened for a ſhort time; at the expiration of which a decrepitation followed at the lower extremity of the flame, which completely divided the wick where the blackened part commences. The whole of the matter in combuſtion therefore fell off, and the candle was of courſe inſtantly extinguiſhed. Whether this would have happened in all proportions of the ſalt or conſtructions of the candle I did not try, becauſe the ſmell of azote was ſufficiently ſtrong and unpleaſant to forbid the uſe of nitre in the purſuit. From various conſiderations I am diſpoſed to think that the ſpontaneous ſnuffing of candles made of tallow, or other fuſible materials, will ſcarcely be effected but by the diſcovery of ſome material for the wick which ſhall be volumnious enough to abſorb the tallow, and at the ſame time ſufficiently flexible to bend on ſide.

“ The moſt promiſing ſpeculation reſpecting this moſt uſeful article, ſeems to direct itſelf to the cup which contains the melted tallow. The imperfection of this part has already been noticed, namely, that it breaks down by fuſion, and ſuffers its fluid contents to eſcape. The Chineſe have a kind of candle about half an inch in diameter, which, in the harbour of Canton, is called *lobchock*; but whether the name be Chineſe, or the corruption of ſome European word, I am ignorant. The wick is of cotton, wrapped round a ſmall ſtick or match of the bamboo cane. The body of the candle is white tallow; but the external part to the thickneſs of perhaps one-thirtieth of an inch, conſiſts of a waxy matter coloured red. This covering gives a conſiderable degree of ſolidity to the candle, and prevents its guttering, becauſe leſs fuſible than the tallow itſelf. I did not obſerve that the ſtick in the middle was either advantageous or the contrary; and, as I now write from the recollection of this object at ſo remote a period as 25 years ago, I can only conjecture that it might be of advantage in throwing up a leſs quantity of oil into the flame than would have been conveyed by a wick of cotton ſufficiently ſtout to have occupied its place unſupported in the axis of the candle.

“ Many years ago I made a candle in imitation of the lobchock. The expedient to which I had recourſe conſiſted in adapting the wick in the uſual pewter mould: wax was then poured in, and immediately afterwards poured out: the film of wax which adhered to the inner ſurface of the mould ſoon became cool; and the candle was completed by filling the mould with tallow. When it was drawn out, it was found to be cracked longitudinally on its ſurface, which I attributed to the contraction of the wax, by cooling, being greater than that of tallow. At preſent I think it equally probable that the cracking might have been occaſioned by too ſudden cooling of the wax before the tallow was poured in; but other avocations prevented the experiments from being varied and repeated. It is probable that the Chineſe external coating may not be formed of pure hard bleached wax.

“ But the moſt deciſive remedy for the imperfection of this cheapeſt, and in other reſpects beſt material for candles, would undoubtedly be to diminiſh its fuſibility. Various ſubſtances may be combined with tallow, either in the direct or indirect method. In the latter way, by the decompoſition of ſoap, a number of experiments were made by Berthollet, of which an account is inſerted in the memoirs of the academy at Paris for the year 1780, and copied into the 26th volume of the Journal de Phyſique. None of theſe point directly to the preſent object; beſides which, it is probable that the ſoap made uſe of by that eminent chemiſt was formed not of tallow, but oil. I am not aware of any regular ſeries of experiments concerning the mutual action of fat oils and other chemical agents, more eſpecially ſuch as may be directed to this important object of diminiſhing its ſolubility; for which reaſon I ſhall mention a few experiments made with this view.

"1. Tallow was melted in a ſmall ſilver veſſel. Solid tallow ſinks in the fluid, and diſſolves without any remarkable appearance. 2. Gum ſandarach in tears was not diſſolved, but emitted bubbles, ſwelled up, became brown, emitted fumes, and became criſp or friable. No ſolution nor improvement of the tallow. 3. Shelllac ſwelled up with bubbles, and was more perfectly fuſed than the gum ſandarach in the former experiment. When the tallow was poured off, it was thought to congeal rather more ſpeedily. The lac did not appear to be altered. 4. Benzoin bubbled without much ſwelling, was fuſed, and emitted fumes of an agreeable ſmell, though not reſembling the flowers of benzoin. A ſlight or partial ſolution ſeemed to take place. The benzoin was ſofter and of a darker colour than before, and the tallow leſs conſiſtent. 5. Common reſin unites very readily with melted tallow, and forms a more fuſible compound than the tallow itſelf. 6. Camphor melts eaſily in tallow, without altering its appearance. When the tallow is near boiling, camphoric fumes fly off. The compound appeared more fuſible than tallow. 7. The acid or flowers of benzoin diſſolves in great quantities without any ebullition or commotion. Much ſmoke ariſes from the compound, which does not ſmell like the acid of benzoin. Tallow alone does not fume at a low heat, though it emits a ſmell ſomething like that of oil-olive. When the proportion of the acid was conſiderable, ſmall needled cryſtals appeared as the temperature diminiſhed. The appearances of ſeparation are different according to the quantity of acid. The compound has the hardneſs and conſiſtence of firm ſoap, and is partially tranſparent. 8. Vitriolated tartar, nitre, white ſugar, cream of tartar, cryſtallized borax, and the ſalt ſold in the markets under the name of ſalt of lemons, but which is ſuppoſed to be the eſſential ſalt of ſorrel, or vegetable alkali ſuperſaturated with acid of ſugar, were reſpectively tried without any obvious mutual action or change of properties in the tallow. 9 Calcined magneſia rendered tallow opake and turbid, but did not ſeem to diſſolve. Its effect reſembled that of lime.

"It is propoſed to try the oxigenated acetous acid, or radical vinegar; the acid of ants, of ſugar, of borax, of galls, the tanning principle, the ſerous and gelatinous animal matter, the fecula of vegetables, vegetable gluten, bird-lime, and other principles, either by direct or indirect application. The object, in a commercial point of view, is entitled to an extenſive and aſſiduous inveſtigation. Chemiſts in general ſuppoſe the hardneſs or leſs fuſibility of wax to ariſe from oxygen, and to this object it may perhaps be advantageous to direct a certain portion of the inquiry. The metallic ſalts and calces are the combinations from which this principle is moſt commonly obtained; but the combinations of theſe with fat oils have hitherto afforded little promiſe of the improvement here ſought. The ſubject is however ſo little known, that experiments of the looſeſt and moſt conjectural kind are by no means to be deſpiſed."

Lighting a CANDLE *by a ſmall ſpark of electricity.* This method, which is an invention of Dr Ingenhoutz, is recorded in the Phil. Tranſ. vol. lxviii. It is done by a ſmall phial, having eight or ten inches of metallic coating, or even leſs, charged with electricity, which may be done at any time of the night by a perſon who has an electric machine in his room. "When I have occaſion to light a candle," ſays he, "I charge a ſmall coated vial, whoſe knob is bent outwards, ſo as to hang a little over the body of the phial; then I wrap ſome looſe cotton over the extremity of a long braſs pin or a wire, ſo as to ſtick moderately faſt to its ſubſtance. I next roll this extremity of the pin wrapped up with cotton in ſome fine powder of reſin, (which I always keep in readineſs upon the table for this purpoſe, either in a wide-mouthed phial or in a looſe paper); this being done, I apply the extremity of the pin or wire to the external coating of the charged phial, and bring as quickly as poſſible the other extremity wrapped round with cotton to the knob: the powder of reſin takes fire, and communicates its flame to the cotton, and both together burn long enough to light a candle. As I do not want more than half a minute to light my candle in this way, I find it a readier method than kindling it by a flint and ſteel, or calling a ſervant. I have found that powder of white or yellow reſin lights eaſier than than of brown. The *farina lycopodii* may be uſed for the ſame purpoſe: but it is not ſo good as the powder of reſin, becauſe it does not take fire quite ſo readily, requiring a ſtronger ſpark not to miſs: beſides, it is ſoon burnt away. By dipping the cotton in oil of turpentine, the ſame effect may be as readily obtained, if you take a jar ſomewhat greater in ſize. This oil will inflame ſo much the readier if you ſtrew a few fine particles of braſs upon it. The pin duſt is the beſt for this purpoſe; but as this oil is ſcattered about by the exploſion, and when kindled fills the room with much more ſmoke than the powder of reſin, I prefer the laſt."

CANDLE-*Bomb*, a name given to ſmall glaſs bubbles, having a neck about an inch long, with a very ſlender bore, by means of which a ſmall quantity of water is introduced into them, and the orifice afterwards cloſed up. This ſtalk being put through the wick of a burning candle, the vicinity of the flame ſoon rarefies the water into ſteam, by the elaſticity of which the glaſs is broken with a loud crack.

CANDLE is alſo a term of medicine, and is reckoned among the inſtruments of ſurgery. Thus the *candela fumalis*, or the *candela pro ſuffitu odorata.* is a maſs of an oblong form, conſiſting of odoriferous powders mixed up with a third or more of the charcoal of willow or lime tree, and reduced to a proper conſiſtence with a mucilage of gum tragacauth, labdanum, or turpentine. It is intended to excite a grateful ſmell without any flame, to correct the air, to fortify the brain, and to excite the ſpirits.

Medicated CANDLE, the ſame with BOUGIE.

CANDLE. Sale or auction by inch of candle, is when a ſmall piece of candle, being lighted, the byſtanders are allowed to bid for the merchandiſe that is ſelling; but the moment the candle is out, the commodity is adjudged to the laſt bidder.

There is alſo an excommunication by inch of candle; when the ſinner is allowed to come to repentance while a candle continues burning; but after it is conſumed, he remains excommunicated to all intents and purpoſes.

Ruſh CANDLES, uſed in different parts of England, are made of the pith of a ſort of ruſhes, peeled or ſtripped of the ſkin, except on one ſide, and dipped in melted greaſe.

CANDLE-*Wood*, ſlips of pine about the thickneſs of a finger, uſed in New England and other colonies to burn inſtead of candles, giving a very good light. The French inhabitants of Tortuga uſe ſlips of yellow ſantal-wood for the ſame purpoſe, and under the ſame denomination, which yields a clear flame though of a green colour.

CANDLEBERRY TREE. See MYRICA, BOTANY *Index*.

CANDLEMAS, a feaſt of the church held on the ſecond day of February, in honour of the purification of the Virgin Mary. It is borrowed from the practice of the ancient Chriſtians, who on that day uſed abundance of lights both in their churches and proceſſions, in memory, as is ſuppoſed, of our Saviour's being on that day declared by Simon "to be a light to lighten the Gentiles." In imitation of this cuſtom, the Roman-catholics on this day conſecrate all the tapers and candles which they uſe in their churches during the whole year. At Rome, the Pope performs that ceremony himſelf; and diſtributes wax-candles to the cardinals and others, who carry them in proceſſion through the great hall of the Pope's palace. This ceremony was prohibited in England by an order of council in 1548.

CANDLEMAS, (2d. Feb.) is made one of the four terms of the year for paying and receiving rents or borrowed money, &c.---In the courts of law, Candlemas term begins 15th January, and ends 3d February.

CANDLESTICK, an inſtrument to hold a candle, made in different forms, and of all ſorts of matter.

The golden candleſtick was one of the ſacred utenſils made by Moſes to be placed in the Jewiſh tabernacle. It was made of hammered gold, a talent in weight. It conſiſted of ſeven branches ſupported by a baſe or foot. Theſe branches were adorned at equal diſtances with ſix flowers like lilies, and with as many bowls and knobs placed alternately. Upon the ſtock and ſix branches of the candleſtick were the golden lamps, which were immovable, wherein were put oil and cotton.

Theſe ſeven lamps were lighted every evening, and extinguiſhed every morning. The lamps had their tongs or ſnuffers to draw the cotton in or out, and diſhes underneath them to receive the ſparks or droppings of the oil. This candleſtick was placed in the antichamber of the ſanctuary on the ſouth ſide, and ſerved to illuminate the altar of perfume and the tabernacle of the ſhew-bread. When Solomon had built the temple of the Lord, he placed in it ten golden candleſticks of the ſame form as that deſcribed by Moſes, five on the north and five on the ſouth ſide of the holy: But after the Babyloniſh captivity, the golden candleſtick was again placed in the temple, as it had been before in the tabernacle by Moſes. This ſacred utenſil, upon the deſtruction of the temple by the Romans, was lodged in the temple of Peace built by Veſpaſian; and the repreſentation of it is ſtill to be ſeen on the triumphal arch at the foot of Mount Palatine, on which Veſpaſian's triumph is delineated.

CANDY, a large kingdom of Aſia, in the iſland of Ceylon. It contains about a quarter of the iſland; and as it is encompaſſed with high mountains, and covered with thick foreſts, through which the roads and paths are narrow and difficult, the king has them guarded to prevent his ſubjects from going into other countries. It is full of hills, from whence rivulets proceed which are full of fiſh; but as they run among the rocks, they are not fit for boats: however, the inhabitants are very dexterous in turning them to water their land, which is fruitful in rice, pulſe, and hemp.

Since the iſland of Ceylon fell into the hands of the Engliſh, we have obtained fuller information reſpecting it. Mr Percival, who has publiſhed an account of this iſland, mentions the jealouſy, both of the Dutch and of the natives, as difficulties which could not have been eaſily ſurmounted by travellers while it remained ſubject to Holland *. "The interior of the iſland (he ſays), owing to the jealouſy of the Dutch, has been little explored by Europeans; and any traveller who might have obtained the permiſſion of the Dutch to viſit it, could not have executed his purpoſe from the jealouſy of the natives. Since the Candians have been driven by their invaders into the mountains of the interior, it has been their policy carefully to prevent any European from ſeeing thoſe objects which might tempt the avarice of his countrymen, or from obſerving the approaches by which an army could penetrate their mountains. If an European by any accident was carried into their territories, they took every precaution to prevent him from eſcaping: and the guards, ſtationed everywhere at the approaches, joined to the wide and pathleſs woods which divide the interior from the coaſt, rendered ſuch an attempt almoſt completely deſperate. When an ambaſſador was ſent from any European government to the king of Candy, he was watched with all that ſtrictneſs and jealouſy, which the ſuſpicious temper of uncivilized nations dictates. In an embaſſy which I attended to the court of that monarch, I had an opportunity of obſerving how careful the natives were to prevent ſtrangers from making any obſervations. Mr Boyd, who about twenty years ago went on a ſimilar embaſſy, was watched with the ſame particular circumſpection; and has therefore been able to add little to our ſtock of knowledge concerning the interior.

"The dominions of the native prince are completely cut off on all ſides from thoſe of the Europeans by almoſt impenetrable woods and mountains. The paſſes which lead through theſe to the coaſts are extremely ſteep and difficult, and ſcarcely known even by the natives themſelves. As ſoon as we advance from ten to twenty miles from the coaſts, a country preſents itſelf greatly differing from the ſea coaſt, both in ſoil, climate, and appearance. After aſcending the mountains and paſſing the woods, we find ourſelves in the midſt of a country not advanced many ſtages beyond

* *Account of Ceylon*, p. 23.

the firſt ſtate of improvement, and which we are aſtoniſhed to find in the neighbourhood of the highly cultivated fields which ſurround Columbo. As we advance towards the centre of the iſland, the country gradually riſes, and the woods and mountains which ſeparate the ſeveral parts of the country become more ſteep and impervious.

"It is in the midſt of theſe faſtneſſes that the native prince ſtill preſerves thoſe remains of territory and power which have been left him by ſucceſſive invaders. His dominions are now much reduced in ſize; for beſides the whole of the ſea coaſts which were of any value, the Dutch, in their various attacks during the laſt century, have contrived to get into their power every tract from which they could derive either emolument or ſecurity. Thoſe provinces which ſtill remain to him, are Nourecalva and Hotcourly towards the north and north-weſt; while Matuly, comprehending the diſtricts of Bintana, Velas, and Panoa, with a few others, occupy thoſe parts more to the eaſtward. To the ſouth-eaſt lies Ouvvah, a province of ſome note, and giving the king one of his titles. The weſtern parts are chiefly included in the provinces of Cotemal and Hotteracorley. Theſe different provinces are ſubdivided into corles or diſtricts, and entirely belong to the native prince. It is needless to recount the names of thoſe diviſions which ſtretch towards the ſea-coaſt, and are now chiefly in our poſſeſſion.

"In the higheſt and moſt centrical part of the native king's dominions lie the corles or counties of Oudanor and Tatanour, in which are ſituated the two principal cities. Theſe counties take the pre-eminence of all the reſt, and are both better cultivated, and more populous, than any of the other diſtricts, and are diſtinguiſhed by the general name of Condé Udda; *condé* or *candé* in the native language ſignifying a mountain, and *udda* the greateſt or higheſt.

"This province of Condé Udda is even more inacceſſible than the others, and forms as it were a ſeparate kingdom of itſelf. On every ſide it is ſurrounded by lofty mountains covered with wood, and the paths by which it is entered ſeem little more than the tracks of wild beaſts. Guards are ſtationed all around to prevent both entrance and eſcape; for defence they might ſeem entirely ſuperfluous, did we not recollect that the perſeverance of the Dutch overcame all theſe obſtacles, and forced a way into the very centre of this natural fortification."

Candy, a town of Aſia, and capital of a kingdom of the ſame name, in the iſland of Ceylon. It has been often burnt by the Portugueſe, when they were maſters of theſe coaſts, It is ſituated E. Long. 79. 12. N. Lat. 7. 35.

We have the following deſcription of Candy by Mr Percival, whom we have already quoted, and who attended an embaſſy to the king.

"In the diſtrict of Tatanour lies Candy, the royal reſidence and the capital of the native prince's dominions. It is ſituated at the diſtance of 80 miles from Columbo, and twice as far from Trincomalee, in the midst of lofty and ſteep hills covered with thick jungle. The narrow and difficult paſſes by which it is approached are interſected with thick hedges of thorn; and hedges of the ſame ſort are drawn round the hills in the vicinity of Candy like lines of circumvallation. Through them the only paſſage is by gates of the ſame thorny materials, ſo contrived as to be drawn up and let down by ropes. When the Candians are obliged to retreat within theſe barriers, they cut the ropes, and then it is impoſſible to force a paſſage except by burning down the gates, which from their green ſtate, and the conſtant annoyance of the enemy ſheltered behind them, would prove an enterpriſe of time and difficulty. Theſe hedge-rows form the chief fortifications of Candy. The Malivagonga alſo nearly ſurrounds the hill on which it ſtands: that river is here broad, rocky, and rapid; a very ſtrict guard is kept on it, and every one who paſſes or repaſſes is cloſely watched and examined.

"The city itſelf is a poor miſerable-looking place, ſurrounded by a mud wall of no ſtrength whatever. It has been ſeveral times burnt by Europeans, and was once deſerted by the king, who retired to a more inacceſſible part of his dominions. It is upon occaſion of the embaſſy of General Macdowal, that any information concerning the preſent ſtate of Candy has been obtained; and even then it could be little more than gueſſed at, as the ambaſſador and his ſuite were admitted only by torch-light, and always retired before break of day. From what could then be obſerved, the city conſiſts of a long ſtraggling ſtreet built on the declivity of a hill; the houſes mean and low, but with their foundations raiſed in ſuch a manner above the level of the ſtreet that they appear quite lofty to paſſengers. The reaſon of this extraordinary taſte is to enable the king to hold his aſſemblies of the people and to have his elephant and buffalo fights in the ſtreet, without interfering with the houſes. When the king paſſes along the ſtreet, none of the inhabitants are allowed to appear before their houſes, or the paths on a level with them, as that would be attended with the heinous indecorum of placing a ſubject higher than the prince deſcended of the ſun.

"At the upper end of this ſtreet, ſtands the palace, a poor manſion for the abode of a king. It is ſurrounded with high ſtone walls, and conſiſts of two ſquares, one within the other. In the inner of theſe are the royal apartments, and it is there that the court is held and audiences given. The exterior of the palace and the reſt of the city could be but very partially obſerved by thoſe who attended General Macdowal, owing to the preſſure of the crowd, and the dazzling glare of the torches. By every account indeed which I have heard, Candy contains nothing worthy of notice, and from the want of either wealth or induſtry among the inhabitants, it is not indeed to be expected that any thing could be met with in this ſtraggling village to attract the attention of the traveller."

Candy, or *Sugar-Candy*, a preparation of ſugar made by melting and cryſtallizing it ſix or ſeven times over, to render it hard or tranſparent. It is of three kinds, white, yellow, and red. The white comes from the loaf-ſugar, the yellow from the caſſonado, and the red from the muſcavado.

CANDYING, the act of preſerving ſimples in ſubſtance, by boiling them in ſugar. The performance of this originally belonged to the apothecaries, but is now become a part of the buſineſs of the confectioner.

CANE, See ARUNDO and CALAMUS, BOTANY *Index*.

CANE, denotes alſo a walking ſtick. It is cuſtomary to adorn it with a head of gold, ſilver, agate, &c. Some are without knots, and very ſmooth and even; others are full of knots about two inches diſtance from one another. Theſe laſt have very little claſticity, and will not bend ſo well as the others.

Canes of Bengal are the moſt beautiful which the Europeans bring into Europe. Some of them are ſo fine, that people work them into bowls or veſſels, which being varniſhed over in the inſide, with black or yellow lacca, will hold liquors as well as glaſs or China ware does; and the Indians uſe them for that purpoſe.

CANE is alſo the name of a long meaſure, which differs according to the ſeveral countries where it is uſed, At Naples the cane is equal to 7 feet 3½ inches Engliſh meaſure: the cane of Thoulouſe and the Upper Languedoc, is equal to the varre of Arragon, and contains five feet 8½ inches; at Montpellier, Provence, Dauphiny, and the Lower Languedoc, to ſix Engliſh feet 5½ inches.

CANEA, a conſiderable town of the iſland of Candia, where a baſhaw reſides. It was built by the Venetians, and occupies part of the ſite of the ancient CYDONIA. It is but about two miles in compaſs; encircled on the land ſide with a ſingle wall, extremely thick; and defended by a broad and deep ditch, cut through a bed of rock, which extends all around the wall. By cutting it ſtill deeper, they might cauſe the ſea to flow round its ramparts; on which they have raiſed high platforms, that their great guns might command a wider extent of the adjacent plain. The city has only one gate, the gate of Retimo, protected by a half-moon battery, which is the only exterior fort. The ſide which faces the ſea is the beſt fortified. On the left of the harbour are four batteries, riſing one above another, and planted with a number of large cannons of caſt metal, marked with the arms of Venice. The firſt of theſe batteries ſtands cloſe on the brink of the ſea. The right ſide of the harbour is defended only by a ſtrong wall, extending along a chain of pointed rocks which it is dangerous for ſhips to approach. At the extremity of this wall, there is an old caſtle, falling into ruins. Beneath that caſtle, the Venetians had immenſe arſenals, vaulted with ſtone. Each of theſe vaults was of ſufficient length, breadth, and height, to ſerve as a work-ſhop for building a ſhip of the line. The ground is ſloping, and the outermoſt part of theſe capacious arſenals is on a level with the ſea; ſo that it was very eaſy to launch the ſhips built there into the water. The Turks are ſuffering that magnificent work to fall into ruins.

The city of Canea is laid out on a fine plan. The ſtreets are large and ſtraight; and the ſquares adorned with fountains. There are no remarkable buildings in it. Moſt of the houſes are flat-roofed, and have only one ſtory. Thoſe contiguous to the harbour are adorned with galleries, from which you enjoy a delightful proſpect. From the windows you diſcover the large bay formed between Cape Spada and Cape Melec, and all the ſhips that are entering in or paſſing out. The harbour, at preſent, receives ſhips of 200 tons burden; and it might be enlarged ſo as to admit the largeſt frigates. Its mouth is expoſed to the violence of the north winds, which ſometimes ſwell the billows above the ramparts. But, as it is narrow, and the bottom is good, ſhips that are well moored run no danger. At the time when Tournefort viſited Crete, Canea did not contain more than five or ſix thouſand inhabitants. But, at preſent, when the gates of Gira-Petra, Candi, and Retimo, are choaked up, the merchants have retired to Canea; and it is reckoned to contain 16,000 ſouls. The environs of the town are admirable; being adorned with foreſts of olive-trees mixed with fields, vineyards, gardens, and brooks bordered with myrtle-trees and laurel-roſes. The chief revenue of this town conſiſts in oil-olive. E. Long. 24. 15. N. Lat. 35. 28.

CANELLA. See BOTANY *Index*.

CANELLE, or CANE LAND, a large country in the iſland of Ceylon, called formerly the *kingdom of Cota*. It contains a great number of cantons, the principal of which are occupied by the Dutch. The chief riches of this country conſiſt in cinnamon, of which there are large foreſts. There are five towns on the coaſt, ſome forts, and a great number of harbours. The reſt of the country is inhabited by the natives; and there are ſeveral rich mines, from whence they get rubies, ſapphires, topazes, cats eyes, and ſeveral other precious ſtones.

CANEPHORÆ, in Grecian antiquity, virgins who when they became marriageable, preſented certain baſkets full of little curioſities to Diana, in order to get leave to depart out of her train, and change their ſtate of life.

CANEPHORIA, in Grecian antiquity, a ceremony which made part of a feaſt, celebrated by the Athenian virgins on the eve of their marriage-day. At Athens the canephoria conſiſted in this, that the maid, conducted by her father and mother, went to the temple of Minerva, carrying with her a baſket full of preſents to engage the goddeſs to make the marriage-ſtate happy; or, as the ſcholiaſt of Theocritus has it, the baſket was intended as a kind of honourable amends made to that goddeſs, the protectrix of virginity, for abandoning her party; or as a ceremony to appeaſe her wrath. Suidas calls it a feſtival in honour of Diana.

CANEPHORIA is alſo the name of a feſtival in honour of Bacchus, celebrated particularly by the Athenians, on which the young maids carried golden baſkets full of fruit, which baſkets were covered, to conceal the myſtery from the uninitiated.

CANES, in Egypt and other eaſtern countries, a poor ſort of buildings for the reception of ſtrangers and travellers. People are accommodated in theſe with a room at a ſmall price, but with no other neceſſaries; ſo that, excepting the room, there are no greater accommodations in theſe houſes than in the deſerts, only that there is a market near.

CANES *Venatici*, in *Aſtronomy*, the Greyhounds, two new conſtellations, firſt eſtabliſhed by Hevelius, between the tail of the Great Bear and Boote's arms, above the Coma Berenices. The firſt is called *aſterion*, being that next the Bear's tail; the other *chara*. They comprehend 23 ſtars, of which Tycho only obſerved two. The longitudes and latitudes of each are given by Hevelius. In the Britiſh Catalogue they are 25.

CANETO, a ſtrong town of Italy in the duchy of Mantua, ſeated on the river Oglio, which was taken by the Imperialiſts in 1701, by the French in 1702, afterwards by the Imperialiſts, and then by the French in 1705. E. Long. 10. 45. N. Lat. 40. 55.

CANGA, in the Chineſe affairs, a wooden clog borne on the neck, by way of puniſhment for divers offences. The canga is compoſed of two pieces of wood notched, to receive the criminal's neck; the load lies on his ſhoulders, and is more or leſs heavy according to the quality of his offence. Some cangas weigh 200lb.; the generality from 50 to 60. The mandarins condemn to the puniſhment of the canga. Sentence of death is ſometimes changed for this kind of puniſhment.

CANGE, Charles du Fresne, Sieur du, one of the moſt learned writers of his time, was born at Amiens in 1601, and ſtudied at the Jeſuits college in that city. Afterwards he applied himſelf to the ſtudy of the law at Orleans, and gained great reputation by his works; among which are, 1. The hiſtory of the empire of Conſtantinople under the French emperors. 2. John Cinnamus's ſix books of the hiſtory of the affairs of John and Manuel Comnenus, in Greek and Latin, with hiſtorical and philological notes. 3. *Gloſſarium ad Scriptores mediæ et infime Latinitatis.*

CANGI, Ceangi, or *Cangani*, anciently a people of Britain, concerning whoſe ſituations antiquaries have been much perplexed. They are all the ſame people. Camden diſcovered ſome traces of them in many different and diſtant places, as in Somerſetſhire, Wales, Derbyſhire, and Cheſhire; and he might have found as plain veſtiges of them in Devonſhire, Dorſetſhire, Eſſex, Wiltſhire, &c. Mr Horſley and others are no leſs perplexed and undetermined in their opinions on this ſubject. But Mr Baxter ſeems to have diſcovered the true cauſe of all this perplexity, by obſerving that the Cangi or Ceangi were not a diſtinct nation ſeated in one particular place, but ſuch of the youth of many different nations as were employed in paſturage, in feeding the flocks and herds of their reſpective tribes. Almoſt all the ancient nations of Britain had their ceangi, their paſtoritia pubes, the keepers of their flocks and herds, who ranged about the country in great numbers, as they were invited by the ſeaſon and plenty of paſture for their cattle. This is the reaſon that veſtiges of their name are to be found in ſo many different parts of Britain; but chiefly in thoſe parts which are moſt fit for paſturage. Theſe ceangi of the different Britiſh nations, naturally brave, and rendered ſtill more hardy by their way of life, were conſtantly armed for the protection of their flocks from wild beaſts; and theſe arms they occaſionally employed in the defence of their country and their liberty.

CANGIAGIO, or Cambiasi Ludovico, one of the moſt eminent of the Genoeſe painters, was born in 1527. His works at Genoa are very numerous; and he was employed by the king of Spain to adorn part of the Eſcurial. It is remarked of him, that he was not only a moſt expeditious and rapid painter, but alſo that he worked equally well with both hands; and by that unuſual power he executed more deſigns, and finiſhed more grand works with his own pencils, in a much ſhorter time, than moſt other artiſts could do with ſeveral aſſiſtants. He died in 1685.

In the royal collection at Paris there is a Sleeping Cupid, as large as life, and likewiſe Judith with her attendant, which are painted by Cangiagio, and are an honour to that maſter. And in the Pembroke collection at Wilton is a picture, reputed the work of Cangiagio, repreſenting Chriſt bearing his croſs.

CANICULA, is a name proper to one of the ſtars of the conſtellation *canis major*, called alſo ſimply the *dog star*; by the Greeks σειριος, *Sirius*. Canicula is the tenth in order in the Britannic catalogue; in Tycho's and Ptolemy's it is the ſecond. It is ſituated in the mouth of the conſtellation; and is of the firſt magnitude, being the largeſt and brighteſt of all the ſtars in the heavens. From the riſing of this ſtar not coſmically, or with the ſun, but heliacally, that is, its emerſion from the ſun's rays, which now happens about the 15th day of Auguſt, the ancients reckoned their *dies caniculares*, or dog days. The Egyptians and Ethiopians began their year at the riſing of the Canicula, reckoning to its riſe again the next year, which is called the *annus canarius*, or canicular year. This year conſiſted ordinarily of 365 days, and every fourth year of 366, by which it was accommodated to the civil year. The reaſon of their choice of the Canicula before the other ſtars to compute their time by, was not only the ſuperior brightneſs of that ſtar, but becauſe its heliacal riſing was in Egypt a time of ſingular note, as falling on the greateſt augmentation of the Nile, the reputed father of Egypt. Epheſtion adds, that, from the aſpect and colour of Canicula, the Egyptians drew prognoſtics concerning the riſe of the Nile; and, according to Florus, predicted the future ſtate of the year; ſo that the firſt riſing of this ſtar was annually obſerved with great attention.

CANICULUM, or Caniculus, in the Byzantine antiquities, a golden ſtandiſh or ink veſſel, decorated with precious ſtones, wherein was kept the ſacred *encaustum*, or red ink, wherewith the emperors ſigned their decrees, letters, &c. The word is by ſome derived from *canis*, or *caniculus*; alluding to the figure of a dog which it repreſented, or rather becauſe it was ſupported by the figures of dogs. The caniculum was under the care of a particular officer of ſtate.

CANINA, the north part of the ancient Epirus, a province of Greece, which now belongs to the Turks, and lies off the entrance of the gulf of Venice. The principal town is of the ſame name, and is ſeated on the ſea coaſt, at the foot of the mountains of Chimera. E. Long. 19. 25. N. Lat. 40. 55.

CANINANA, in *Zoology*, the name of a ſpecies of ſerpent found in America, and eſteemed one of the leſs poiſonous kinds. It grows to about two feet long; and is green on the back, and yellow on the belly. It feeds on eggs and ſmall birds; the natives cut off the head and tail, and eat the body as a delicate diſh.

CANINE, whatever partakes of, or has any relation to, the nature of a dog.

Canine *Appetite*, amounts to much the ſame with Bulimy.

Canine *Madneſs*. See Medicine *Index*.

CANINE *Teeth*, are two ſharp-edged teeth in each jaw; one on each ſide, placed between the inciſores and molares.

CANINI, JOHN ANGELO and MARC ANTHONY, brothers and Romans, celebrated for their love of antiquities. John excelled in deſigns for engraving on ſtones, particularly heads; Marc engraved them. They were encouraged by Colbert to publiſh a ſucceſſion of heads of the heroes and great men of antiquity, deſigned from medals, antique ſtones, and other ancient remains; but John died at Rome ſoon after the work was begun: Marc Anthony, however, procured aſſiſtance, finiſhed and publiſhed it in Italian in 1669. The cuts of this edition were engraved by Canini, Picard, and Valet; and a curious explanation is given, which diſcovers the ſkill of the Caninis in hiſtory and mythology. The French edition of Amſterdam, in 1731, is ſpurious.

CANIS, or DOG. See MAMMALIA *Index*.

CANIS *Major*, the Great Dog, in *Aſtronomy*, a conſtellation of the ſouthern hemiſphere, below Orion's feet, though ſomewhat to the weſtward of him; whoſe ſtars Ptolemy makes 29; Tycho obſerved only 13; Hevelius 21; in the Britannic catalogue they are 31.

CANIS *Minor*, the Little Dog, in *Aſtronomy*, a conſtellation of the northern hemiſphere; called alſo by the Greeks, *Procyon*, and by the Latins *Antecanis* and *Canicula*. The ſtars in the conſtellation Canis Minor, are in Ptolemy's catalogue, 2; in Tycho's, 5; in Hevelius's, 13; and in the Britiſh catalogue, 14.

CANISIUS, HENRY, a native of Nimeguen, and one of the moſt learned men of his time, was profeſſor of canon law at Ingolſtadt; and wrote a great number of books; the principal of which are, 1. *Summa Juris Canonici*. 2. *Antiquæ Lectiones*, a very valuable work. He died in 1609.

CANITZ, the baron of, a German poet and ſtateſman, was of an ancient and illuſtrious family in Brandenburg, and born at Berlin in 1654, five months after his father's death. After his early ſtudies, he travelled to France, Italy, Holland, and England; and upon his return to his country, was charged with important negotiations by Frederic II. Frederic III employed him alſo. Canitz united the ſtateſman with the poet; and was converſant in many languages, dead as well as living. His German poems were publiſhed for the tenth time, 1750, in 8vo. He is ſaid to have taken Horace for his model, and to have written purely and delicately. But he did not content himſelf with barely cultivating the fine arts in himſelf; he gave all the encouragement he could to them in others. He died at Berlin, in 1699, privy counſellor of ſtate, aged 45.

CANKER, a diſeaſe incident to trees, proceeding chiefly from the nature of the ſoil. It makes the bark rot and fall. If the canker be in a bough, cut it off; in a large bough, at ſome diſtance from the ſtem; in a ſmall one, cloſe to it: but for over hot ſtrong ground, the ground is to be cooled about the roots with pond mud and cow dung.

CANKER, among farriers. See FARRIERY *Index*.

CANNA, INDIAN REED. See BOTANY *Index*.

CANNABIS, HEMP. See BOTANY *Index*.

From the leaves of hemp pounded and boiled in water, the natives of the Eaſt Indies prepare an intoxicating liquor of which they are very fond. The plant, when freſh, has a rank narcotic ſmell; the water in which the ſtalks are ſoaked, in order to ſeparate the tough rind for mechanic uſes, is ſaid to be violently poiſonous, and to produce its effects almoſt as ſoon as drank. The ſeeds alſo have ſome ſmell of the herb, and their taſte is unctuous and ſweetiſh: they are recommended, boiled in milk, or triturated with water into an emulſion, againſt coughs, heat of urine, and the like. They are alſo ſaid to be uſeful in incontinence of urine, and for reſtraining venereal appetites; but experience does not warrant their having any virtues of that kind.

CANNÆ, in *Ancient Geography*, a town of Apulia on the Adriatic, at the mouth of the river Aufidus, rendered famous by a terrible overthrow which the Romans here received from the Carthaginians under Hannibal. The Roman conſuls, Æmilius Paulus and Terentius Varro, being authorized by the ſenate to quit the defenſive plan, and ſtake the fortunes of the republic on the chance of a battle, marched from Canuſium, and encamped a few miles eaſt, in two unequal diviſions, with the Aufidus between them. In this poſition they meant to wait for an opportunity of engaging to advantage; but Hannibal, whoſe critical ſituation in a deſolated country, without refuge or allies, could admit of no delay, found means to inflame the vanity of Varro by ſome trivial advantages in ſkirmiſhes between the light horſe. The Roman, elated with this ſucceſs, determined to bring matters to a ſpeedy concluſion; but, finding the ground on the ſouth ſide too confined for the operations of ſo large an army, croſſed the river; and Varro, reſting his right wing upon the Aufidus, drew out his forces in the plain. Hannibal, whoſe head-quarters were at Cannæ, no ſooner perceived the enemy in motion, than he forded the water below, and marſhalled his troops in a line oppoſite to that of his adverſaries.

The Romans were vaſtly ſuperior in number to the Carthaginians; but the latter were ſuperior in cavalry. The army of the former, conſiſting of 87,000 men, was drawn up in the uſual manner; the *haſtati* in the firſt line, the *principes* in the ſecond, and the *triarii* in the third. The cavalry were poſted on the wings.--- On the right, the Roman knights flanked the legionaries; on the left, the cavalry of the allies covered their own infantry. The two conſuls commanded the two wings, Æmilius the right, and Terentius the left; and the two proconſuls, Servilius and Attilius, the main body. On the other hand, Hannibal, whoſe army conſiſted of 40,000 foot and 10,000 horſe, placed his Gauliſh and Spaniſh cavalry in his left wing, to face the Roman knights; and the Numidian horſe in his right, over-againſt the cavalry of the allies of Rome. As to his infantry, he divided the African battalions into two bodies; one of which he poſted near the Gauliſh and Spaniſh horſe, the other near the Numidian. Between theſe two bodies were placed on one ſide the Gauliſh, on the other the Spaniſh infantry, drawn up in ſuch a manner as to form an obtuſe angle projecting a conſiderable way beyond the two wings. Behind this line he drew up a ſecond which had no projection. Aſdrubal commanded the left wing; Maherbal the right; and Hannibal himſelf, with his brother

Mago, the main body. He had alſo taken care to poſt himſelf in ſuch a manner, that the wind *Vulturnus*, which riſes at certain ſtated times, ſhould blow directly in the faces of the Romans during the fight, and cover them with duſt. The onſet was begun by the light-armed infantry; the Romans diſcharging their javelins, and the *baleares* their ſtones, with pretty equal ſucceſs; nevertheleſs, the conſul Æmilius was wounded.—Then the Roman cavalry in the right wing advanced againſt the Gauliſh and Spaniſh in Hannibal's left. As they were ſhut in by the river Aufidus on one ſide, and by their infantry on the other, they did not fight, as uſual, by charging and wheeling off, and then returning to the charge; but continued fighting each man againſt his adverſary, till one of them was killed or retired. After they had made prodigious efforts on both ſides to overbear each other, they all on a ſudden diſmounted, and fought on foot with great fury. In this attack the Gauls and Spaniards ſoon prevailed; put the Romans to the route; and, purſuing them along the river, ſtrewed the ground with their dead bodies, Aſdrubal giving no quarter. This action was ſcarce over, when the infantry on both ſides advanced. The Romans firſt fell upon the Spaniards and Gauls, who, as already obſerved, formed a kind of triangle projecting beyond the two wings. Theſe gave ground, and, purſuant to Hannibal's directions, ſunk into the void ſpace in their rear; by which means they inſenſibly brought the Romans into the centre of the African infantry; and then the fugitives rallying, attacked them in front, while the Africans charged them in both flanks. The Romans being, by this artful retreat, drawn into the ſnare and ſurrounded, no longer kept their ranks, but formed ſeveral platoons in order to face every way. Æmilius, who was on the right wing, ſeeing the danger of the main body, at the head of his legionaries acted the part both of a ſoldier and general, penetrating into the heart of the enemy's battalions, and cutting great numbers of them in pieces. All the Roman cavalry that were left, attended the brave conſul on foot; and, encouraged by his example, fought like men in deſpair. But, in the mean time, Aſdrubal, at the head of a detachment of Gauliſh and Spaniſh infantry brought from the centre, attacked Æmilius's legionaries with ſuch fury, that they were forced to give ground and fly: the conſul, being all covered with wounds, was at laſt killed by ſome of the enemy who did not know him. In the main body, the Romans, though inveſted on all ſides, continued to ſell their lives dear; fighting in platoons, and making a great ſlaughter of the enemy. But being at length overpowered, and diſheartened by the death of the two proconſuls, Servilius and Attilius, who headed them, they diſperſed and fled, ſome to the right, and others to the left, as they could find opportunity; but the Numidian horſe cut moſt of them in pieces: the whole plain was covered with heaps of dead bodies, inſomuch that Hannibal himſelf, thinking the butchery too terrible, ordered his men to put a ſtop to it.—There is a great diſagreement among authors as to the number of Romans killed and taken at the battle of Cannæ. According to Livy, the republic loſt 50,000 men, including the auxiliaries. According to Polybius, of 6000 Roman horſe, only 70 eſcaped to Venuſia with Terentius Varro, and 300 of the auxiliary horſe. As to the infantry, that writer tells us, that 70,000 of the Roman foot died on the field of battle fighting like brave men; and that 13,000 were made priſoners. According to Dionyſius of Halicarnaſſus, of 6000 horſe, only 370 eſcaped the general ſlaughter, and of 80,000 foot, 3000 only were left. The moſt moderate computation makes the number of Romans killed to amount to 45,000. The ſcene of action is marked out to poſterity, by the name of *Pezzo di Sangue*, "Field of Blood."

Theſe plains have more than once, ſince the Punic war, afforded room for men to accompliſh their mutual deſtruction. Melo of Bari, after raiſing the ſtandard of revolt again the Greek emperors, and defeating their generals in ſeveral engagements, was at laſt routed here in 1019, by the Catapan Bolanus. Out of 250 Norman adventurers, the flower of Melo's army, only ten eſcaped the ſlaughter of that day. In 1201, the archbiſhop of Palermo and his rebellious aſſociates, who had taken advantage of the nonage of Frederick of Swabia, were cut to pieces at Cannæ by Walter de Brienne, ſent by the Pope to defend the young king's dominions.

The traces of the town of Cannæ are very faint, conſiſting of fragments of altars, cornices, gates, walls, vaults, and under-ground granaries. It was deſtroyed the year before the battle: but, being rebuilt, became an epiſcopal ſee in the infancy of Chriſtianity. It was again ruined in the ſixth century, but ſeems to have ſubſiſted in a humble ſtate many ages later; for we read of its contending with Barletta for the territory which till then had been enjoyed in common by them; and in 1284, Charles I. iſſued an edict for dividing the lands, to prevent all future litigation. The proſperity of the towns along the coaſt, which increaſed in wealth and population by embarkations of the cruſades and by traffic, proved the annihilation of the great inland cities; and Cannæ was probably abandoned entirely before the end of the thirteenth century.

CANNEQUINS, in commerce, white cotton cloths brought from the Eaſt Indies. They are a proper commodity for trading on the coaſt of Guinea, particularly about the rivers Senegal and Gambia. Theſe linens are folded ſquare-wiſe, and are about eight ells long.

CANNEL COAL. See MINERALOGY *Index*.

CANNES, a town of France, in Provence, and in the viguerie of Graſſe, ſeated on the coaſt of the Mediterranean ſea, with a harbour and a caſtle. E. Long. 7. 7. N. Lat. 43. 34.

CANNIBAL, a modern term for an anthropophagus or man-eater, more eſpecially in the Weſt Indies. See ANTHROPOPHAGI.

CANNON, a military engine for throwing balls, &c. by the help of GUNPOWDER.

The invention of braſs cannon is by Laney aſcribed to J. Owen: he ſays, that they were firſt known in England in the year 1535; but yet acknowledges, that, in 1346, there were four pieces of cannon in the Engliſh army at the battle of Creſſy, and that theſe were the firſt that were known in France. And Mezeray relates, that King Edward, by five or ſix pieces of cannon, ſtruck terror into the French army, it being the firſt time they had ſeen any of theſe thundering

ing machines; though others affirm that cannon were known alſo in France at the ſame time; but that the French king, in his hurry to attack the Engliſh, and in confidence of victory, left all his cannon behind him as uſeleſs encumbrances (See Artillery). The Germans carry the invention farther back, and attribute it to Albertus Magnus, a Dominican monk, about the year 1250. Voſſius rejects all theſe opinions, and finds cannon in China almoſt 1700 years ago. According to him, they were mounted by the emperor Kitey in the year of Chriſt 85. For further particulars of their hiſtory, &c. ſee Gun and Gunnery.

For the caſting of cannon, ſee Foundery. For their different parts, proportions, management, operation, and effect, ſee Gunnery.

Cannon, with letter-founders and printers, the name of the largeſt ſize of letters they uſe.

CANNONADE, the application of artillery to the purpoſes of war, or the direction of its efforts againſt ſome diſtant object intended to be ſeized or deſtroyed, as a ſhip, battery, or fortreſs. See Gunnery.

Since a large ſhip of war may be conſidered as a combination of floating batteries, it is evident that the efforts of her artillery muſt be greatly ſuperior to thoſe of a fortreſs on the ſea coaſt; that is to ſay, in general; becauſe, on ſome particular occaſions, her ſituation may be extremely dangerous, and her cannonading ineffectual. Her ſuperiority conſiſts in ſeveral circumſtances, as the power of bringing her different batteries to converge to one point; of ſhifting the line of her attack ſo as to do the greateſt poſſible execution againſt the enemy, or to lie where ſhe will be the leaſt expoſed to his ſhot; and chiefly becauſe, by employing a much greater number of cannon againſt a fort than it can poſſibly return, the impreſſion of her artillery againſt ſtone walls ſoon becomes deciſive and irreſiſtible. Beſides theſe advantages in the attack, ſhe is alſo greatly ſuperior in point of defence; becauſe the cannon ſhot, paſſing with rapidity through her ſides ſeldom do any execution out of the line of their flight, or occaſion much miſchief by their ſplinters; whereas they very ſoon ſhatter and deſtroy the faces of a parapet, and produce incredible havock among the men by the fragments of the ſtones, &c. A ſhip may alſo retreat when ſhe finds it too dangerous to remain longer expoſed to the enemy's fire, or when her own fire cannot produce the deſired effect. Finally, The fluctuating ſituation of a ſhip, and of the element on which ſhe reſts, renders the effects of bombs very uncertain, and altogether deſtroys the effect of the *ricochet*, or rolling and bounding ſhot, which is ſo pernicious and deſtructive in a fortreſs or land engagement. The chief inconveniency to which a ſhip is expoſed, on the cantrary, is, that the low-laid cannon in a fort near the brink of the ſea, may ſtrike her repeatedly on or under the ſurface of the water, ſo as to ſink her before her cannonade can have any conſiderable efficacy.

CANO, a kingdom of Africa, in Negroland, with a town of the ſame name. It is bounded by Zaara on the north, by the river Niger on the ſouth, the Kingdom of Agades on the weſt, and that of Caſhna on the eaſt. Some of the inhabitants are herdſmen, and others till the ground and dwell in villages. It produces corn, rice, and cotton. Here are alſo many deſerts, and mountains covered with woods, in which are wild citrons and lemon trees. The walls and houſes of the town are made of clay, and the principal inhabitants are merchants. E. Long. 16. 18. N. Lat. 21. 5.

CANOBIA, a town of Italy, in the duchy of Milan, ſeated on the weſtern bank of Lago Maggiore, or the Greater Lake. E. Long. 8. 47. N. Lat. 45. 55.

CANOE, a ſort of Indian boat or veſſel, formed of the trunk of a tree hollowed, and ſometimes of ſeveral pieces of the bark put together.

Canoes are of various ſizes, according to the uſes for which they may be deſigned, or the countries wherein they are formed. The largeſt are made of the cotton tree; ſome of them will carry between 20 and 30 hogſheads of ſugar or molaſſes. Some are made to carry ſail: and for this purpoſe are ſteeped in water till they become pliant; after which their ſides are extended, and ſtrong beams placed between them, on which a deck is afterwards laid that ſerves to ſupport their ſides. The other ſorts very rarely carry ſail, unleſs when going before the wind: their ſails are made of a ſort of ſhort ſilk graſs or ruſhes. They are commonly rowed with paddles, which are pieces of light wood ſomewhat reſembling a corn ſhovel; and, inſtead of rowing with it horizontally like an oar, they manage it perpendicularly. The ſmall canoes are very narrow, having only room for one perſon in breadth, and ſeven or eight lengthwiſe. The rowers, who are generally American ſavages, are very expert in managing their paddles uniformly, and in balancing the canoes with their bodies; which would be difficult for a ſtranger to do, how well accuſtomed ſoever to the conducting of European boats, becauſe the canoes are extremely light, and liable to be overturned. The American Indians, when they are under the neceſſity of landing to avoid a water-fall, or of croſſing the land from one river to another, carry their canoes on their heads, till they arrive at a place where they can launch them again. This is the general conſtruction of canoes, and method of managing them: but ſome nations have veſſels going under the name of canoes, which differ conſiderably from the above; as the inhabitants of Greenland, Hudſon's bay, Otaheite, &c.

CANON, a perſon who poſſeſſes a prebend, or revenue alloted for the performance of divince ſervice, in a cathedral, or collegiate church.

Canons are of no great antiquity: Paſchier obſerves, that the name canon was not known before Charlemagne; at leaſt the firſt we hear of are in Gregory de Tours, who mentions a college of canons inſtituted by Baldwin XVI. archbiſhop of that city, in the time of Clotharius I. The common opinion attributes the inſtitution of this order to Chrodegangus, biſhop of Metz, about the middle of the eighth century.

Originally canons were only prieſts, or inferior eccleſiaſtics, who lived in community; reſiding by the cathedral church, to aſſiſt the biſhop; depending entirely on his will; ſupported by the revenues of the biſhopric; and living in the ſame houſe, as his domeſtics, or counſellors, &c. They even inherited his moveables, till the year 817, when this was prohibited by the council of Aix-la-Chapelle, and a new rule ſubſtituted in the place of that which had been appointed by Chrodegangus, and which was obſerved for the moſt part in the weſt till the 12th century. By degrees, theſe communities of prieſts, ſhaking off their dependence, formed ſeparate bodies; whereof the biſhops, however, were ſtill heads. In the tenth century, there were communities or congregations of the ſame kind, eſtabliſhed even in cities where there were no biſhops: theſe were called collegiates, as they uſed the terms congregation and college indifferently: the name chapter, now given to theſe bodies, being much more modern. Under the ſecond race of the French kings, the canonical, or collegiate life, had ſpread itſelf all over the country; and each cathedral had its chapter, diſtinct from the reſt of the clergy. They had the name canon from the Greek κανων, which ſignifies three different things; a rule, a penſion or fixed revenue to live on, and a catalogue or matricula; all which are applicable to them.

In time, the canons freed themſelves from their rules, the obſervance relaxed, and, at length, they ceaſed to live in community: yet they ſtill formed bodies; pretending to other functions beſides the celebration of the common office in the church; yet aſſuming the rights of the reſt of the clergy: making themſelves as a neceſſary council of the biſhop; taking upon them the adminiſtration of a ſee during a vacancy, and the election of a biſhop to ſupply it. There are even ſome chapters exempt from the juriſdiction of the biſhop, and owning no head but their dean. After the example of cathedral chapters, collegiate ones alſo continued to form bodies, after they had abandoned living in community.

CANONS are of various kinds; as,

Cardinal CANONS, which are thoſe attached, and, as the Latins call it, *incardinati* to a church, as a prieſt is to a pariſh.

Domicellary CANONS, were young canons, who, not being in orders, had no right in any particular chapters.

Expectative CANONS, were ſuch as, without having any revenue or prebend, had the title and dignities of canons, a voice in the chapter, and a place in the choir; till ſuch time as a prebend ſhould fall.

Foreign CANONS, were ſuch as did not officiate in the canonries to which they belonged. To theſe were oppoſed manſionary canons, or canons reſidentiary.

Lay or *honorary* CANONS, are ſuch among the laity as have been admitted, out of honour and reſpect, into ſome chapter of canons.

Regular CANONS, are canons that ſtill live in community; and who, like religious, have, in proceſs of time, to the practice of their rules, added the ſolemn profeſſion of vows. They are called regulars, to diſtinguiſh them from thoſe ſecular canons who abandon living in community, and at the ſame time the obſervance of the canons made as the rule of the clergy, for the maintenance of the ancient diſcipline. The canons ſubſiſted in their ſimplicity till the eleventh, ſome ſay the twelfth century, when ſome of them, ſeparating from the community, took with them the name of canons, or acephalous prieſts, becauſe they declined to live in community with the biſhop; and thoſe who were left thenceforth acquired the denomination of canons regular, and adopted moſt of the profeſſions of the rule of St Auguſtine. This order of regular canons of St Auguſtine was brought into England by Adelwald, confeſſor to Henry I., who erected a priory at Noſtel in Yorkſhire; and obtained for them the church of Carliſle as an epiſcopal ſee, with the privilege of chooſing their own biſhop. They were ſingularly protected and encouraged by Henry I. who gave them the priory of Dunſtable in 1107, and by Queen Maud, who, in the following year, gave them the priory of the Holy Trinity in London. It appears, that under the reign of Edward I. they had fifty-three priories.

Tertiary CANONS, thoſe who had only the third part of the revenues of the canonicate.

CANON, in an eccleſiaſtical ſenſe, is a law or rule, either of doctrine or diſcipline, enacted eſpecially by a council, and confirmed by the authority of the ſovereign.

Canons are properly deciſions of matters of religion; or regulations of the policy and diſcipline of a church, made by councils, either general, national, or provincial. Such are the canons of the council of Nice, or Trent, &c.

There have been various collections of the canons of the eaſtern councils; but four principal ones, each ampler than the preceding. The firſt, according to Uſher, A. D. 380, containing only thoſe of the firſt ecumenical council, and the firſt provincial ones: they were but 164 in number. To theſe, Dionyſius Exiguus, in the year 520, added the 50 canons of the apoſtles, and thoſe of the other general councils. The Greek canons in this ſecond collection end with thoſe of the council of Chalcedon; to which are ſubjoined thoſe of the council of Sardica, and the African councils. The fourth and laſt collection comes down as low as the ſecond council of Nice; and it is on this that Balſamon and Zonaras have commented.

Apoſtolical CANONS, are thoſe which have been uſually aſcribed to St Clement. Bellarmin, Baronius, &c. will have them to be genuine canons of the apoſtles: Catelerius obſerves, that they cannot be aſcribed to the apoſtles or Clement, becauſe they are not received with other books of Scripture, are not quoted by the writers of the firſt ages, and contain many things not agreeable to the apoſtolical times: Hincmar, De Marca, Beveridge, &c. take them to be framed by the biſhops who were the apoſtles diſciples in the ſecond or third century; S. Baſnage is of opinion that they were collected by an anonymous writer in the fifth century; but Daille, &c. maintain them to have been forged by ſome heretic in the ſixth century; and S. Baſnage conjectures that ſome of them are ancient, and others not older than the ſeventh century. The Greek church allows only 85 of them, and the Latins only 50; though there are 84 in the edition given of them in the Corpus Juris Canonici.

CANON is alſo uſed for the authorized catalogue of the ſacred writings. See BIBLE.

The ancient canon, or catalogue of the books of the Old Teſtament, was made by the Jews, and is ordinarily attributed to Ezra; who is ſaid to have diſtributed them into the law, the prophets, and the hagiographa, to which our Saviour refers, Luke, chap. xxiv. ver. 44. The ſame diviſion is alſo mentioned by Joſephus, cont. Appion.

This is the canon allowed to have been followed by the primitive church, till the council of Carthage; and, according to St Jerome, this conſiſted of no more than 22 books; anſwering to the number of the Hebrew alphabet; though at preſent they are claſſed into 24 diviſions, containing Geneſis, Exodus, Leviticus, Numbers, Deuteronomy, Joſhua, Judges, Samuel, Kings, Iſaiah, Jeremiah, Ezekiel, the twelve minor prophets, the Pſalms, the Proverbs, Job, Canticles, Ruth, Lamentations, Eccleſiaſtes, Eſther, Daniel, Ezra, comprehending the book of Nehemiah and the Chronicles. However, this order is not univerſally obſerved either among Jews or Chriſtians: nor were all the books above enumerated admitted into the canon in Ezra's time. It is moſt likely, ſays Dr Prideaux, that the two books of Chronicles, Ezra, Nehemiah, Eſther, and Malachi, were added in the time of Simon the Juſt, when the canon was completed. But that council enlarged the canon very conſiderably, taking into it the books which we call apocryphal: which the council of Trent has further enforced, enjoining all theſe to be received as books of Holy Scripture, upon pain of anathema, and being attainted of hereſy. The Romaniſts, in defence of this canon, ſay, that it is the ſame with that of the council of Hippo, held in 393; and with that of the third council of Carthage, in 397, at which were preſent 46 biſhops, and, among the reſt, St Auguſtine; who declared that they received it from their fathers.

Their canon of the New Teſtament perfectly agrees with ours. It conſiſts of books that are well known; ſome of which have been univerſally acknowledged; ſuch are the four Goſpels, the Acts of the Apoſtles, thirteen Epiſtles of St Paul, one Epiſtle of St Peter, and one Epiſtle of St John; and others, concerning which doubts were entertained, but which were afterwards received as genuine; ſuch are the epiſtle to the Hebrews, that of James, the ſecond of Peter, the ſecond and third of John, that of Jude, and the Revelation. Theſe books were written at different times; and they are authenticated, not by the decrees of councils, or infallible authority, but by ſuch kind of evidence as is thought ſufficient in the caſe of any other ancient writings. They were very extenſively diffuſed; they were read in every Chriſtian ſociety; they were valued and preſerved with care by the firſt Chriſtians; they were cited by Chriſtian writers of the ſecond, third, and fourth century, as by Irenæus, Clement the Alexandrian, Tertullian, Origen, Euſebius, &c. and their genuineneſs is proved by the teſtimony of thoſe who were contemporary with the apoſtles themſelves, and by tradition. The four Goſpels, and moſt of the other books of the New Teſtament, were collected either by one of the apoſtles, or ſome of their diſciples and ſucceſſors, before the end of the firſt century. The catalogue of canonical books furniſhed by the more ancient Chriſtian writers, as Origen about the year 210, Euſebius and Athanaſius in 315, Epiphanius in 370, Jerome in 382, Auſtin in 394, and many others, agrees with that which is now received among Chriſtians. For the time of writing the ſeveral books of the New Teſtament, ſee the titles of the books themſelves; as the Goſpel of St MATTHEW, MARK, &c.

Some of the fathers diſtinguiſh the inſpired writings into three claſſes; proto-canonical, deutero-canonical, and apocryphal.

Paschal CANON, a table of the moveable feaſts, ſhowing the day of Eaſter, and the other feaſts depending on it, for a cycle of 19 years.

The paſchal canon is ſuppoſed to be the calculation of Euſebius of Cæſarea, and to have been done by order of the council of Nice.

CANON, in monaſtic orders, a book wherein the religious of every convent have a fair tranſcript of the rules of their order, frequently read among them as their local ſtatutes. This is alſo called *regula*, as containing the rule and inſtitution of their order.

The canon differs from the miſſale, martyrologium, and necrologium.

CANON, again, is uſed for the catalogue of ſaints acknowledged and canonized in the Roman church.

CANON is alſo uſed, by way of excellence, in the Romiſh church, for the ſecret words of the maſs, from the preface to the *Pater*; in the middle of which the prieſt conſecrates the hoſt. The common opinion is, that the canon of the maſs commences with *Te igitur*, &c. The people are to be on their knees, hearing the canon; and are to rehearſe it to themſelves, ſo as not to be heard.

CANON, in the ancient muſic, is a rule or method of determining the intervals of notes.

Ptolemy, rejecting the Ariſtoxenian way of meaſuring the intervals in muſic, by the magnitude of a tone (which was ſuppoſed to be formed by the difference between a diapente and a diateſſaron), thought that muſical intervals ſhould be diſtinguiſhed, according to the ratios or proportions which the ſounds terminating thoſe intervals bear to one another, when conſidered according to their degree of acuteneſs or gravity; which, before Ariſtoxenus, was the old Pythagorean way. He therefore made the diapaſon conſiſt in a double ratio; the diapente, in a ſeſquialterate; the diateſſaron, in a ſeſquitertian; and the tone itſelf, in a ſeſquioctave; and all the other intervals, according to the proportion of the ſounds that terminate them: wherefore taking the canon (as it is called) for a determinate line of any length, he ſhows how this canon is to be cut accordingly, ſo that it may repreſent the reſpective intervals: and this method anſwers exactly to experiment, in the different lengths of muſical chords. From this canon, Ptolemy and his followers have been called *Canonici*; as thoſe of Ariſtoxenus were called *Muſici*.

CANON, in modern muſic, is a kind of fugue, which they call a *perpetual fugue*, becauſe the different parts beginning one after another, repeat inceſſantly the ſame air.

Formerly, ſays Zarlino, they placed, at the head of perpetual fugues, particular directions which ſhowed how this kind of fugues was to be ſung; and theſe directions, being properly the rules by which perpetual fugues were compoſed, were called *canoni*, *rules* or *canons*. From this cuſtom, others taking the title for the thing ſignified, by a metonymy, termed this kind of compoſition *canon*. Such canons as are compoſed with the greateſt facility, and of conſequence moſt generally uſed, begin the fugue either with the octave or the uniſon; that is to ſay, that every part repeats in the ſame tone the melody of the preceding. In order to form a canon of this kind, it is only neceſſary for the compoſer to make an air according to his taſte; to add in ſcore as many parts as he chooſes, where the voices in octave or uniform repeat the ſame melody; then forming a ſingle air from all theſe parts ſucceſſively executed, to try whether this ſucceſſion may form an entire piece which will give pleaſure, as well in the harmony as the melody.

In order to execute ſuch a *canon*, he who ſings the firſt part begins alone, and continues till the air is finiſhed; then recommences immediately, without any ſuſpenſe of ſound or interruption of time; as ſoon as he has ended the firſt couplet, which ought to ſerve for the perpetual ſubject upon which the whole *canon* has been compoſed, the ſecond part begins and repeats the ſame couplet, whilſt the firſt who had begun purſues the ſecond: others in ſucceſſion begin and proceed the ſame way, as ſoon as he who precedes has reached the end of the firſt couplet. Thus, by inceſſantly recommencing, an univerſal cloſe can never be found, and the *canon* may be repeated as long as the ſingers pleaſe.

A perpetual fugue may likewiſe conſiſt of parts which begin with the intervals of a fourth or fifth; or, in other words, every part may repeat the melody of the firſt, a fourth or a fifth higher or lower. It is then neceſſary that the whole *canon* ſhould be invented *di prima intenzione*, as the Italians ſay; and that ſharps or flats ſhould be added to the notes, whoſe natural gradations do not anſwer exactly, by a fourth or fifth, to the melody of the preceding part, and produce the ſame intervals with itſelf. Here the compoſer cannot pay the leaſt regard to modulation; his only care is, that the melody may be the ſame, which renders the formation of a *canon* more difficult; for at every time when any part reſumes the fugue, it takes a new key; it changes the tone almoſt at every note, and, what is ſtill worſe, no part is at the ſame time found in the ſame tone with another; hence it is that this kind of *canons*, in other reſpects far from being eaſy to be peruſed, never produce a pleaſing effect, however good the harmony may be, and however properly it may be ſung.

There is a third kind of *canon*, but very ſcarce, as well becauſe it is extremely difficult, as becauſe it is for the moſt part incapable of giving pleaſure, and can boaſt no other merit but the pains which have been thrown away in its compoſition. This may be called a *double canon inverted*, as well by the inverſions which are practiſed in it with reſpect to the melody of the parts, as by thoſe which are found among the parts themſelves in ſinging. There is ſuch an artifice in this kind of *canon*, that, whether the parts be ſung in their natural order, or whether the paper in which they are ſet be turned the contrary way, to ſing them backward from the end to the beginning, in ſuch a manner that the baſs becomes the upper part, and the reſt undergo a ſimilar change, ſtill you have pretty harmony, and ſtill a regular *canon*. The reader may conſult Rouſſeau's Dictionary in this article, where he is referred to Plate D. fig. 11. for two examples of canons of this ſort extracted from Bontempi, who likewiſe gives rules for their compoſition. But he adds, that the true principle from which this rule is deduced will be found at the word *Syſteme*, in his account of the ſyſtem of Tartini, to which we muſt likewiſe once more refer the reader; as a quotation of ſuch length muſt have protracted our article to an enormous extent.

To form a *canon*, in which the harmony may be a little varied, it is neceſſary that the parts ſhould not follow each other in a ſucceſſion too rapid, and that the one ſhould only begin a conſiderable time after the other. When they follow one another ſo immediately as at the diſtance of a ſemibreve or a minim, the duration is not ſufficient to admit a great number of chords, and the canon muſt of neceſſity exhibit a diſagreeable monotony; but it is a method of compoſing, without much difficulty, a canon in as many parts as the compoſer chooſes. For a *canon* of four bars only, will conſiſt of eight parts, if they follow each other at the diſtance of half a bar; and by each bar which is added, two parts will conſtantly be gained.

The emperor Charles VI. who was a great muſician, and compoſed extremely well, took much pleaſure in compoſing and ſinging *canons*. Italy is ſtill replete with moſt beautiful *canons* compoſed for this prince, by the beſt maſters in that country. To what has been ſaid by Rouſſeau, we need only ſubjoin, that the Engliſh *catch* and the Italian *canon* are much the ſame; as any intelligent reader may perceive, from comparing the ſtructure and execution of the Engliſh *catch* with the account of *canons* which has now been given.

CANON, in *Geometry* and *Algebra*, a general rule for the ſolution of all caſes of a like nature with the preſent inquiry. Thus every laſt ſtep of an equation is a canon; and, if turned into words, becomes a rule to ſolve all queſtions of the ſame nature with that propoſed.

CANON *Law*, a collection of eccleſiaſtical laws, ſerving as the rule and meaſure of church-government.

The power of making laws was exerciſed by the church before the Roman empire became Chriſtian. The canon law that obtained throughout the weſt, till the 12th century, was the collection of canons made by Dionyſius Exiguus in 520, the capitularies of Charlemagne, and the decrees of the popes from Sircius to Anaſtaſius.

The canon law, even when papal authority was at its height in England, was of no force when it was found to contradict the prerogative of the king, the laws, ſtatutes, and cuſtoms of the realm, or the doctrine of the eſtabliſhed church.

The eccleſiaſtical juriſdiction of the ſee of Rome in England was founded on the canon law; and this created quarrels between kings and ſeveral archbiſhops and prelates who adhered to the papal uſurpation.

Beſides the foreign canons, there were ſeveral laws and conſtitutions made here for the government of the church: but all theſe received their force from the royal aſſent; and if, at any time, the eccleſiaſtical courts did, by their ſentence, endeavour to enfore obedience to ſuch canons, the courts at common law, upon complaints made, would grant prohibition. The authority veſted in the church of England of making canons, was aſcertained by a ſtatute of Henry VIII. cammonly called the *act of the clergy's ſubmiſſion*; by which they acknowledged, that the convocation had always been aſſembled by the king's writ; ſo that,

Canoneſs || Canonical puniſhments.

though the power of making canons reſided in the clergy met in convocation, their force was derived from the authority of the king's aſſenting to and confirming them.

The old canons continued in full force till the reign of James I. when the clergy being aſſembled in convocation, the king gave them leave to treat and conſult upon canons; which they did, and preſented them to the king, who gave them the royal aſſent: theſe were a collection out of the ſeveral preceding canons, and injunctions. Some of theſe canons are now obſolete. In the reign of Charles I. ſeveral canons were paſſed by the clergy in convocation.

CANONESS, in the Romiſh church, a woman who enjoys a prebend, affixed, by the foundation, to maids, without their being obliged to renounce the world, or make any vows.

CANONICA, in philoſophical hiſtory, an appellation given by Epicurus to his doctrine of logic. It was called *canonica*, as conſiſting of a few canons or rules for directing the underſtanding in the purſuit and knowledge of truth. Epicurus's *canonica* is repreſented as a very ſlight and inſufficient logic by ſeveral of the ancients, who put a great value on his ethics and phyſics. Laertius even aſſures us, that the Epicureans rejected logic as a ſuperfluous ſcience; and Pluturch complains that Epicurus made an unſkilful and prepoſterous uſe of ſyllogiſms. But theſe cenſures ſeem too ſevere. Epicurus was not averſe to the ſtudy of logic, but even gave better rules in this art than thoſe philoſophers who aimed at no glory but that of logics. He only ſeems to have rejected the dialectics of the Stoics, as full of vain ſubtleties and deceits, and fitted rather for parade and diſputation than real uſe. The ſtreſs of Epicurus's *canonica* conſiſts in his doctrine of the criteria of truth. All queſtions in philoſophy are either concerning words or things: concerning things, we ſeek their truth; concerning words, their ſignification: things are either natural or moral; and the former are either perceived by ſenſe or by the underſtanding. Hence, according to Epicurus, ariſe three criterions of truth, viz. ſenſe, anticipation or prænotion, and paſſion. The great canon or principle of Epicurus's logic is, that the ſenſes are never deceived; and therefore, that every ſenſation or perception of an appearance is true.

CANONICAL, ſomething that belongs to, or partakes of, the nature of a rule or canon.

Canonical Hours, are certain ſtated times of the day, conſigned, more eſpecially by the Romiſh church, to the offices of prayer and devotion. Such are *matins*, *lauds*, *ſixth*, *ninth veſpers*. In our country the canonical hours are from eight to twelve in the forenoon, before or after which marriage cannot be legally performed in any pariſh church.

Canonical *Obedience*, is that ſubmiſſion which, by the eccleſiaſtical laws, the inferior clergy are to pay to their biſhops, and religious to their ſuperiors.

Canonical *Sins*, in the ancient church, thoſe which were capital or mortal. Such eſpecially were idolatry, murder, adultery, hereſy, and ſchiſm.

Canonical *Puniſhment*, are thoſe which the church may inflict; ſuch as excommunication, degradation, and penance, in Roman Catholic countries, alſo faſting, alms, whipping, &c.

Canonical life || Canoniſt.

Canonical *Life*, the method or rule of living preſcribed by the ancient clergy who lived in community. The canonical life was a kind of medium between the monaſtic and clerical lives. Originally the orders of monks and clerks were entirely diſtinct; but pious perſons, in proceſs of time, inſtituted colleges of prieſts and canons, where clerks, brought up for the miniſtry, as well as others already engaged therein, might live under a fixed rule, which, though ſomewhat more eaſy than the monaſtic, was yet more reſtrained than the ſecular. This was called the *canonical life*, and thoſe who embraced it *canons*. Authors are divided about the founder of the canonical life. Some will have it to be founded by the apoſtles; others aſcribe it to Pope Urban I. about the year 1230, who is ſaid to have ordered biſhops to provide ſuch of their clergy as were willing to live in community, with neceſſaries out of the revenues of their churches. The generality attribute it to St Auguſtine; who, having gathered a number of clerks to devote themſelves to religion, inſtituted a monaſtery within the eſpiſcopal palace, where he lived in community with them. Onuphrius Panvinus brings the inſtitution ſomewhat lower; according to him, Pope Gelaſius I. about the year 495, placed the firſt regular canons of St Auguſtine in the Lateran church.

Canonical *Letters*, in the ancient church, were a ſort of teſtimonials of the orthodox faith, which the biſhops and clergy ſent each other to keep up the Catholic communion, and diſtinguiſh orthodox Chriſtians from Arians and other heretics. They were denominated *canonical*, either as being compoſed according to a certain rule or form, or becauſe they were given to the *canonici*, that is, thoſe comprehended in the canon or catalogue of their church. When they had occaſion to travel into other dioceſes or countries, dimiſſory and recommendatory letters, alſo letters of peace, &c. were ſo many ſpecies of canonical letters.

Canonical is alſo an appellation given to thoſe epiſtles in the New Teſtament more frequently called *catholic* or *general* epiſtles.

CANONICUM in a general ſenſe, denotes a tax or tribute.

Canonicum is more particulary uſed in the Greek church for a fee paid by the clergy to biſhops, archbiſhops, and metropolitans, for degrees and promotions.

Canonicum alſo denotes a due of firſt fruits, paid by the Greek laity to their biſhops, or, according to Du Cange, to their prieſts. The *canonicum* is affected according to the number of houſes or chimneys in a place.

The emperor Iſaac Comnenus made a conſtitution for regulating the *canonicum* of biſhops, which was confirmed by another made in 1086, by his nephew Alexis Comnenus. A village containing thirty fires, was to pay for its *canonicum* one piece of gold, two of ſilver, one ſheep, ſix buſhels of barley, ſix of wheat flour, ſix meaſures of wine, and thirty hens.

CANONIST, a perſon ſkilled in or who makes profeſſion of the ſtudy and practice of the canon law. Canoniſts and civilians are uſually combined in the ſame perſons: and hence the title of *doctor juris utriuſque*, or *legum doctor*, uſually expreſſed in abbreviature, L. L. D, or J. U. D.

CANONIZATION, a ceremony in the Romiſh church, by which perſons deceaſed are ranked in the catalogue of the ſaints. It ſucceeds beatification.

Before a beatified perſon is canonized, the qualifications of the candidate are ſtrictly examined into, in ſome conſiſtories held for that purpoſe; after which, one of the conſiſtorial advocates, in the preſence of the pope and cardinals, makes the panegyric of the perſon who is to be proclaimed a ſaint, and gives a particular detail of his life and miracles: which done, the holy father decrees his canonization, and appoints the day.

On the day of canonization the pope officiates in white, and their eminences are dreſt in the ſame colour. St Peter's church is hung with rich tapeſtry, upon which the arms of the pope, and of the prince or ſtate requiring the canonization, are embroidered in gold and ſilver. An infinite number of lights blaze all round the church, which is crowded with pious ſouls, who wait with devout impatience till the new ſaint has made his public entry as it were into paradiſe, that they may offer up their petitions to him without danger of being rejected.

The following maxim with regard to canonization is now obſerved, though it has not been followed above a century, viz. not to enter into the inquiries prior to canonization, till 50 years, at leaſt, after the death of the perſon to be canonized. By the ceremony of canonization, it appears that this rite of the modern Romans has ſomething in it very like the apotheoſis or deification of the ancient Romans, and, in all probability, takes its riſe from it; at leaſt ſeveral ceremonies of the ſame nature are conſpicuous in both.

CANONRY, the benefice filled by a canon. It differs from a prebend, in that the prebend may ſubſiſt without the canonicate, whereas the canonicate is inſeparable from the prebend: again, the right of ſuffrages, and other privileges, are annexed to the canonicate, and not to the prebend.

CANOPUS, in *Aſtronomy*, a ſtar of the firſt magnitude in the rudder of Argo, a conſtellation of the ſouthern hemiſphere.

CANOPUS, in Pagan mythology, one of the deities of the ancient Egyptians, and, according to ſome, the god of water. It is ſaid, that the Chaldeans, who worſhipped fire, carried their fancied deity through other countries to try its powers, in order that, if it obtained the victory over the other gods, it might be acknowledged as the true object of worſhip; and it having eaſily ſubdued the gods of wood, ſtone, braſs, ſilver, and gold, its prieſts declared that all gods did it homage. This the prieſt of Canopus hearing, and finding that the Chaldeans had brought their god to contend with Canopus, they took a large earthen veſſel, in which they bored ſeveral holes, which they afterwards ſtopped with wax, and having filled the veſſel with water, painted it of ſeveral colours, and fitting the head of an idol to it, brought it out, in order to contend with the Chaldean deity. The Chaldeans accordingly kindled their fire all around it; but the heat having melted the wax, the water guſhed out through the holes, and extinguiſhed the fire; and thus Canopus conquered the god of the Chaldeans.

CANOPUS, or *Canobus*, according to Strabo, had been Menelaus's pilot, and had a temple erected to him in a town called *Canopus*, near one of the mouths of the Nile. Dionyſius mentions it:

> Και τεμειος περιπυςον Αμυκλαι οιο Κανωβου.
> There ſtands Canobus' temple known to fame:
> The pilot who from fair Amycla came.

Voſſius remarks on this occaſion, the vanity of the Greeks, who, as he conjectures, hearing of an Egyptian deity named *Canopus*, took from thence an opportunity of deifying the pilot of Menelaus who bore the ſame name, and giving out that the Egyptian god Canopus had been a Greek. F. Manfaucon gives ſeveral repreſentations of this deity. One, in alluſion to the victory above-mentioned, throws out water on every ſide through little holes.

CANOPUS, or *Canobus*, in *Ancient Geography*, a town of the Lower Egypt, on the Mediterranean, a hundred and twenty ſtadia, or fifteen miles, to the eaſt of Alexandria; as old as the war of Troy, Canopus, or Canobus, Menelaus's ſteerſman, being there buried. *Canopaei* the gentilitious name; famous for their luxury and debauchery, (Strabo, Juvenal.) See ABOUKIR.

CANOPY, in *Architecture* and *Sculpture*, a magnificent kind of decoration, ſerving to cover and crown an altar, throne, tribunal, pulpit, chair, or the like. The word is formed from the barbarous Latin *canopeum*, of κωνωπειον, *a net ſpread over a bed to keep off the gnats*. from κωνωψ, *a gnat*.

Canopies are alſo borne over the head in proceſſions of ſtate, after the manner of umbrellas. The canopy of an altar is more peculiarly called *ciborium*.

The Roman grandees had their canopies, or ſpread veils, called *thenſæ*, over their chairs: the like were alſo in temples over the ſtatues of the gods. The modern cardinals ſtill retain the uſe of canopies.

CANOSA, a town of Puglia in Italy, occupying part of the ſite of the ancient Canuſium. The old city was founded by Diomedes, according to Strabo. It afterwards became a Roman colony, and one of the moſt conſiderable cities of this part of Italy for extent. population, and magnificence of building. The era of Trajan ſeems to have been that of its greateſt ſplendour: but this pomp only ſerved to mark it as a capital object for the avarice and fury of the Barbarians. Genſeric, Totila, and Autharis, treated it with extreme cruelty. The deplorable ſtate to which this province was reduced in 590 is conciſely but ſtrongly painted by Gregory the Great in theſe terms: "On every ſide we hear groans; on every ſide we behold crowds of mourners, cities burnt, caſtles razed to the ground, countries laid waſte, provinces become deſerts, ſome citizens led away captives, and others inhumanly maſſacred." No town in Puglia ſuffered more than Canoſa from the outrages of the Saracens; the conteſts between the Greeks and Normans increaſed the meaſure of its woes, which was filled by a conflagration that happened when it was ſtormed by Duke Robert. In 1090, it was aſſigned, by agreement, to Bohemund prince of Antioch, who died here in 1111. Under the reign of Ferdinand the Third, this eſtate belonged to the Grimaldis. On their forfeiture, the Affaititi acquired it, and ſtill retain the title of marquis, though the Capeci are the proprietors of the fief.

Swinburne's Travels in Sicily. page 408.

The ancient city ſtood in a plain between the hills and the river Ofanto, and covered a large tract of ground. Many brick monuments, though degraded and ſtripped of their marble caſing, ſtill atteſt its ancient grandeur. Among them may be traced the fragments of aqueducts, tombs, amphitheatres, baths, military columns, and two triumphal arches, which by their poſition, ſeem to have been two city gates. The preſent town ſtands above, on the foundations of the old citadel, and is a moſt pitiful remnant of ſo great a city, not containing above three hundred houſes. The church of Sabinus, built, as is ſaid, in the ſixth century, is now without the encloſure. It is aſtoniſhing that any part of this ancient cathedral ſhould have withſtood ſo many calamities. Its altars and pavements are rich in marble; and in a ſmall court adjoining, under an octagonal cupola, is the mauſoleum of Bohemund, adorned in a minute Gothic ſtyle.

CANSO, a ſea port town of Acadia, or Nova Scotia, in North America, ſeated on a narrow ſtrait which ſeparates Nova Scotia from Cape Breton. Near this town is a fine fiſhery for cod. W. Long. 62. N. Lat. 46.

CANSTAT, a town of Swabia, in Germany, in the duchy of Wirtemberg, ſituated on the river Neckar, in E. Long. 9. 9. N. Lat. 48. 51.

CANT, a quaint affected manner of ſpeaking, adapted chiefly to the lower ſort. Skinner racks his invention for the origin of this word; which he ſucceſſively deduces from the German, Flemiſh, and Saxon tongues. According to the general opinion, Cant is originally the proper name of a Cameronian preacher in Scotland, who by exerciſe had attained the faculty of talking in the pulpit in ſuch a tone and dialect as was underſtood by none but his own congregation: ſince Andrew Cant's time, the word has been extended to ſignify all ſudden exclamations, and whining unmuſical tones, eſpecially in praying and preaching. But this origin of the word has been diſputed by others; and perhaps the true derivation is from the Latin *cantare* "to ſing."

Cant is alſo applied to words and phraſes affected by particular perſons or profeſſions for low ends, and not authorized by the eſtabliſhed language *. The difference between *cant* and *technical* ſeems to be this: the former is reſtrained to words introduced out of folly, affectation, or impoſture: the latter is applied to ſuch as are introduced for the ſake of clearneſs, preciſion and ſignificancy.

* See *Canting Language.*

Cant is alſo uſed to denote a ſale by auction. The origin of the word in this ſenſe is dubious; it may come, according to ſome, from *quantum*, how much; according to others, from *cantare*, to ſing or cry aloud; agreeably to which, we ſometimes alſo call it an *outcry*.

Cant, *Timbers*, in ſhip-building, thoſe timbers which are ſituated at the two ends of a ſhip. They derive their name from being *canted*, or raiſed obliquely from the keel; in contradiſtinction from thoſe whoſe planes are perpendicular to it. The upper ends of thoſe on the bow, or fore part of the ſhip, are inclined to the ſtern; as thoſe in the after or hind part, incline to the ſtern poſt above. See *Ship-Building*.

CANTABRIA, in *Ancient Geography*, a diſtrict of Tarraconenſies, on the Oceanus Cantabricus, or bay of Biſcay; now Biscay. The inhabitants were famous for their warlike character. In conjunction with the Aſturians †, they carried on deſperate wars with the Romans; but were ſubdued by them about 25 years before Chriſt. Being impatient, however, of a foreign yoke, they in a few years revolted. Moſt of their youth had been already taken priſoners by the Romans, and ſold for ſlaves to the neighbouring nations: but having found means to break their chains, they cut the throats of their maſters; and returning into their own country, attacked the Roman garriſons with incredible fury. Agrippa marched againſt them with great expedition; but on his arrival, met with ſo vigorous a reſiſtance, that his ſoldiers began to deſpair of ever being able to reduce them. As the Cantabrians had waged war with the Romans for upwards of 200 years, they were well acquainted with their manner of fighting, no way inferior to them in courage, and were now become deſperate; well knowing, that if they were conquered, after having ſo often attempted to recover their liberty, they muſt expect the moſt ſevere uſage, and cruel ſlavery. Animated with this reflection, they fell upon the Romans with a fury hardly to be expreſſed, routed them in ſeveral engagements, and defended themſelves when attacked by the enemy with ſuch intrepidity, that Agrippa afterwards owned that he had never, either by ſea or land, been engaged in a more dangerous enterpriſe. That brave commander was obliged to uſe entreaties, menaces, and to brand ſome of his legionaries with ignominy, before he could bring them to enter the liſts with ſuch a formidable enemy. But having at laſt, with much ado, prevailed upon them to try the chance of an engagement in the open field, he ſo animated them by his example, that, after a moſt obſtinate diſpute, he gained a complete victory, which indeed coſt him dear, but put an end to that deſtructive war. All the Cantabrians fit to bear arms were cut in pieces; their caſtles and ſtrong holds taken and razed; and their women, children, and old men (none elſe being left alive), were obliged to abandon the mountainous places, and ſettle in the plain.

† See *Aſturias.*

Dr Wallis ſeems to make the Cantabrian the ancient language of all Spain; which, according to him, like the Gauliſh, gave way to a kind of broken Latin called *romance, romanſh;* which by degrees was refined into the Caſtilian or preſent Spaniſh. But we can hardly ſuppoſe that ſo large a country, inhabited by ſuch a variety of people, ſpoke all the ſame language. The ancient Cantabrian, in effect, is ſtill found to ſubſiſt in the more barren and mountainous parts of the province of Biſcay, Aſturias, and Navarre, as far as Bayonne, much as the Britiſh does in Wales; but the people only talk it: for writing, they uſe either the Spaniſh or French, as they happen to live under the one or the other nation. Some attribute this to a jealouſy of foreigners learning the myſteries of their language; others to a poverty of words and expreſſions. The Cantabrian does not appear to have any affinity with any other known language, abating that ſome Spaniſh words have been adopted in it for things whoſe uſe the Biſcayans were anciently unacquainted with. Its pronunciation is not diſagreeable. The Lord's prayer, in the Cantabrian tongue, runs thus: *Gure aita cervetan aicena, santifica bedi hire icena, ethor ledi hire resuma,* *eguin bedi hire vorondatea cervan becala lurrean ere*, &c.

CANTABRICA, in *Botany*: a ſynonyme of a ſpecies of CONVOLVULUS.

CANTABRUM, in *Antiquity*, a large kind of flag uſed by the Roman emperors, diſtinguiſhed by its peculiar colour, and bearing on it ſome word or motto of good omen, to encourage the ſoldiers.

CANTACUZENUS, JOHANNES, of Conſtantinople, a celebrated ſtateſman, general, and hiſtorian, was born in that city, of a very ancient and noble family. He was bred to letters and to arms, and admitted to the higheſt offices of the ſtate. The emperor Andronicus loaded him with wealth and honour; made him generaliſſimo of his forces; and was deſirous of having him join him in the government, but this he refuſed. Andronicus dying in 1341, left to Cantacuzenus the care of the empire, till his ſon John Paleologus, who was then but nine years of age, ſhould be fit to take it upon himſelf. This truſt he faithfully diſcharged; till the empreſs-dowager and her faction forming a party againſt him, declared him a traitor. On this the principal nobility and the army beſought him to aſcend the throne; and accordingly he was crowned on the 21ſt of May 1342. This was followed by a civil war, which laſted five years; when he admitted John a partner with him in the empire, and their union was confirmed by his giving him his daughter in marriage. Suſpicions and enmities, however, ſoon ariſing, the war broke out again, and continued till John took Conſtantinople in 1355. A few days after, Cantacuzenus, unwilling to continue the effuſion of blood, abdicated his ſhare of the empire, and retiring to a monaſtery, took the habit of a monk, and the name of *Joaſaphas*. His wife alſo retired to a nunnery, and changed her name of *Irene* for that of *Eugenia*. In this retirement he lived till the year 1411, when he was upwards of 100 years of age. Here he wrote a hiſtory of his own times, a Latin tranſlation of which, from the Greek manuſcript, was publiſhed by Pontanus at Ingolſtadt, in 1603: and a ſplendid edition was printed at Paris in 1645, in three volumes folio, of the original Greek, and Potanus's Latin verſion. He alſo wrote an apology for the Chriſtian religion againſt that of Mahomet, under the name of *Chriſtodulus*.

CANTALIVERS, in *Architecture*, pieces of wood framed into the front or ſides of a houſe, to ſuſpend the mouldings and eyes over it.

CANTAR, or CANTARO, an eaſtern weight, of different value in different places, equal at Acra in Turkey to 603 pounds, at Tunis and Tripoli to 114 pounds.

CANTAR is alſo an Egyptian weight, which is denominated a *quintal*, and conſiſts of a hundred or of an hundred and fifty rotolos, according to the goods they are to weigh.

CANTARO is alſo an Egyptian weight, which at Naples is equivalent to 25 pounds, at Genoa to 150 pounds. At Leghorn there are three kinds of *cantaros*, one weighing 150 pounds, another 151, and a third 160 pounds.

CANTARO is alſo a Spaniſh liquid meaſure, in uſe eſpecially at Alicant, containing three gallons.

CANTARO is alſo a meaſure of capacity, uſed at Cochin, containing four rubis, the rubi 32 rotolos.

CANTARINI, SIMON, a famous painter, called the *Peſareſe*, from his being born at Peſaro, was the diſciple of Guido; and copied the manner of his maſter ſo happily, that it is often difficult to diſtinguiſh between their works. He died at Verona in 1648.

CANTATA, in *Muſic* a ſong or compoſition, intermixed with recitatives, airs, and different movements, chiefly intended for a ſingle voice, with a thorough baſs, though ſometimes for other inſtruments.

The cantata, when performed with judgment, has ſomething in it very agreeable; the variety of the movement not clogging the ear, like other compoſitions. It was firſt uſed in Italy, then in France, whence it paſſed to us.

CANTAZARO, an epiſcopal city of Italy, in the kingdom of Naples, and in the territory of Calabria Ulterior. It is the reſidence of the governor of the province, and is ſeated near the ſea, in E. Long. 17. 0. N. Lat. 38. 59.

CANTECROIX, a ſmall territory of the Netherlands, in Brabant, and in the quarter of Antwerp, with the title of a principality; there is a ſmall town of the ſame name, but Lire is the capital.

CANTEMIR, DEMETRIUS, ſon of a prince of Moldavia. Diſappointed by not ſucceeding his father in that dignity, held under the Ottoman Porte, he went over with his army to the Czar Peter the Great, againſt whom he had been ſent by the Grand Signior: He ſignalized himſelf in the czar's ſervice; and in the republic of letters, by a Latin hiſtory of the origin and decline of the Ottoman empire, &c. He died in 1723.

CANTEMIR, *Antiochus*, eſteemed the founder of the Ruſſian poetry, was the youngeſt ſon of the preceding. Under the moſt ingenious profeſſors, whom the czar had invited to Peterſburgh, he learned mathematics, phyſic, hiſtory, moral philoſophy, and polite literature; without neglecting the ſtudy of the Holy Scriptures, to which he had a great inclination. Scarce had he finiſhed his academic courſe, when he printed a Concordance of the Pſalms in the Ruſſian language, and was elected member of the academy. The affairs of ſtate in which he was ſoon after engaged, did not make him neglect his literary purſuits. In order to make himſelf uſeful to his fellow citizens, he compoſed his ſatires, to ridicule certain prejudices which had got footing among them. When but 24 years of age, he was nominated miniſter at the court of Great Britain; and his dexterity in the management of public affairs was as much admired as his taſte for the ſciences. He had the ſame reputation in France, whither he went in 1738 in quality of miniſter plenipotentiary, and ſoon after was inveſted with the character of ambaſſador extraordinary. The wiſe and prudent manner in which he conducted himſelf during the different revolutions which happened in Ruſſia durring his abſence, gained him the confidence and eſteem of three ſucceſſive princes. He died of a dropſy, at Paris, in 1744, aged 44. Beſides the pieces already mentioned, he wrote, 1. Some Fables and Odes. 2. A tranſlation of Horace's Epiſtles in Ruſſian verſe. 3. A

Canterbury.

proſe tranſlation of Fontenelle's Plurality of Worlds; and, 4. Algarotti's Dialogues on Sight. The Abbé Guaſco has written his life in French, and tranſlated his ſatires into that language.

CANTERBURY, a city of England, and capital of the county of Kent, ſituated in E. Long. 1. 15. N. Lat. 51. 16. It had the names of *Durovernum* and *Darvernum* given it by the Romans, and *Duroberria* by Bede, which are thought to be derived from *Durwhern*, ſignifying a rapid ſtream, ſuch as the Stour, on which it ſtands, is. The Britons call it *Caer Kent*, i. e. the city of Kent; and its preſent Engliſh name is of the ſame import, derived from the Saxon. Modern writers in Latin call it *Cantuaria*. Its great antiquity appears not only from Antoninus's Itinerary, but from the military way which has been diſcovered here, and the cauſeways leading to Dover and Lymme, beſides the coins and other curioſities found about it. The archiepiſcopal and metropolitan dignity ſeems to have been ſettled here very early; and to prevent its being removed, an anathema was decreed againſt any who ſhould attempt it. After that, the city flouriſhed greatly; though it ſuffered in common with other towns during the Daniſh invaſions, and at other times by the cauſualties of fire. The city was given entirely to the biſhops by William Rufus, and was held in the utmoſt veneration in the Popiſh times, eſpecially after the murder of Becket in the reign of Henry II. to whoſe ſhrine ſo great was the reſort, and ſo rich were the offerings, that Eraſmus, who was an eye-witneſs of its wealth, ſays the whole church and chapel in which he was interred glittered with jewels; and at the diſſolution, the plate and jewels filled two great cheſts, each of which required eight ſtrong men to carry out. The cathedral was granted by Ethelbert, king of Kent, upon his converſion, to Auſtin the monk, together with his palace, and the royalty of the city and its territories. This Auſtin founded a monaſtery for monks, called from him *Auguſtine*. After the cathedral had been ſeveral times deſtroyed by fire and rebuilt, the preſent was begun about the year 1174, and augmented and embelliſhed by the ſucceeding archbiſhops, till it was completed in the reign of Henry V. It is a noble Gothic pile, and before the Reformation had 37 altars. A great many kings, princes, cardinals, and archbiſhops, are buried in it. At the diſſolution, Henry VIII. ſeized all the revenues both of the church and monaſtery, except what he allotted for the maintenance of a dean, 12 prebendaries, and ſix preachers, whom he eſtabliſhed in place of the monks. During the grand rebellion, it ſuffered much; the uſurper Cromwell having made a ſtable of it for his dragoons. After the Reſtoration, it was repaired, and made what it now appears.

Beſides the cathedral and other churches, as well as a monaſtery, the city had anciently a caſtle on the ſouth ſide, and ſtrong walls, with towers, a ditch, and rampart; it had alſo a mint and an exchange. As to its government, it ſeems to have been entirely ſubject to the archbiſhop, both in ſpirituals and temporals; at leaſt from the time that William Rufus gave it ſolely to Biſhop Anſelm, till the Reformation. It is now a county of itſelf: and the corporation conſiſts of a mayor, recorder, 12 aldermen, a ſheriff, 24 common council men, a mace-bearer, ſword-bearer, and four ſerjeants at mace. Every Monday a court is held at Guildhall for civil and criminal cauſes: and every other Tueſday for the government of the city. Here were formerly 2000 or 3000 French Proteſtants employed in the ſilk manufacture; but this branch is now greatly decayed in the place, ſince Spittalfields became ſo flouriſhing. Beſides the cathedral, it contains 15 pariſh churches, ſeven hoſpitals, a free-ſchool, a houſe of correction, a goal for criminals, and ſumptuous conduit for ſupplying the inhabitants with water. It conſiſts of four ſtreets, diſpoſed in the form of a croſs, and divided into ſix wards, which are about three miles in circumference. It is ſurrounded on all hands with hop grounds much to its advantage, and is famed for its excellent brawn.

Canterbury
bell,
Canterus.

The dioceſe of Canterbury contains 257 pariſhes, beſides chapels, in Kent, and about 100 more in other dioceſes. Theſe are called *Peculiars*; it being an ancient privilege of this ſee, that, whereſoever the archbiſhops had either manors or advowſons, the place was exempted from the juriſdiction of the ordinary of the dioceſe where it was ſituated, and was deemed in the dioceſe of Canterbury. This ſee is valued in the king's books at 2816l. 17s. 9½d, but is reckoned to produce a clear revenue of 8000l. a year. The clergy's tenths come to 615l. 18s. 2½. This ſee had many great privileges in the time of Popery, ſome of which it ſtill retains. The archbiſhop is accounted primate and metropolitan of all England, and is the firſt peer in the realm; having the precedence of all dukes not of the blood-royal, and of all the great officers of ſtate. In common ſpeech he is ſtyled *His Grace*, and he writes himſelf *Divina Providentia*; whereas other biſhops ſtyle themſelves *Divina Permiſſione*. At coronations, he places the crown on the king's head; and, wherever the court may be, the king and queen are the proper domeſtic pariſhioners of the archbiſhop of Canterbury. The biſhop of London is accounted his provincial dean, the biſhop of Wincheſter his ſub-dean, the biſhop of Lincoln his chancellor, and the biſhop of Rocheſter his chaplain. This ſee hath yielded to the church 18 ſaints; to the church of Rome, 9 cardinals; to the civil ſtate of England, 12 lord chancellors, 4 lord treaſurers, and 1 lord chief juſtice; and 9 chancellors to the univerſity of Oxford. To this ſee belongs only one archdeacon, viz. of Canterbury. To the cathedral belongs an archbiſhop, a dean, a chancellor, an archdeacon, 12 prebends, 6 preachers, 6 minor canons, 6 ſubſtitutes, 12 lay clerks, 10 choriſters, 2 maſters, 50 ſcholars, and 12 almſmen.

CANTERBURY *Bell*, the Engliſh name of a ſpecies of CAMPANULA. See BOTANY, *Index*.

CANTERUS, WILLIAM, an eminent linguiſt and philologer, was born at Utrecht, in 1541. He ſtudied at Louvain and Paris; and gave ſurpriſing proofs of his progreſs in Greek and Latin literature. He afterwards viſited the ſeveral univerſities of Germany and Italy; and died at Louvain, in 1575, aged 33. He underſtood ſix languages, beſides that of his native country; and, notwithſtanding his dying ſo young, wrote ſeveral philological and critical works, among which are, *Notæ, Scholia, Emendationes, et Explicationes, in Euripidem, Sophoclem, Eschylem, Ciceronem, Propertium, Ausonium*, &c. and many tranſlations of Greek authors.

CANTHARIDES, in the *Materia Medica*, flies which are employed to produce bliſters on the ſkin.

CANTHARIS, in *Zoology*, a genus of inſects belonging to the order of inſecta coleoptera. Linnæus enumerates 27 ſpecies of the cantharis, moſt of them to be found in different parts of Europe. The cantharis uſed in making bliſtering plaſters is ranked under the genus Meloe. See Entomology *Index*.

CANTHI, in *Anatomy*, cavities at the extremities of the eyelids, commonly called the *corners of the eye*: the greater of them, or the great canthus, is next the noſe; the leſſer of them, or the little canthus, lies towards the temple.

CANTICLES, a canonical book of the Old Teſtament, otherwiſe called the *Song of Solomon;* by the Jews the *Song of Songs*, *Canticum Canticorum.* The book of Canticles is uſually ſuppoſed to be an epithalamium compoſed by Solomon, on occaſion of his marriage with the king of Egypt's daughter. But thoſe who penetrate further into the myſtery, find in it the marriage of Jeſus Chriſt with human nature, the church, and good men. On this principle the Canticles is held to be a continued allegory, wherein, under the terms of a common wedding, a divine and ſpiritual marriage is expreſſed. This ſong contains the adventures of ſeven days and ſeven nights; the exact time allowed for the celebration of marriage among the Hebrews. The Jews themſelves, apprehending the book liable to be underſtood in a groſs and carnal manner, prohibited the reading of it before the age of 30, and the ſame uſage anciently obtained in the Chriſtain Church. Among the ancients, Theodore Mopſuetanus rejected the book of Canticles as not divine. Divers rabbins have alſo queſtioned its being written by inſpiration. It is alleged, that the name of God is not once found in it. Mr Whiſton has a diſcourſe expreſs to prove that the Canticles is not a ſacred book of the Old Teſtament. He alleges it indeed to have been written by king Solomon the ſon of David; but aſſerts that it was compoſed at the time when that prince, blinded by his concubines, was ſunk in luſt and idolatry. This he chiefly infers from the general character of vanity and diſſoluteneſs which reigns through the Canticles: in which there is not, according to Whiſton, one thought that leads the mind towards religion, but all is worldly and carnal, to ſay no worſe. For the myſtic ſenſe, he aſſerts it to be without foundation; and that the book is not cited is canonical by any writer before the deſtruction of Jeruſalem. Mr Whiſton will have it to have been taken into the canon between the year 77 and 128, when allegories came into vogue, and the rabbins began to corrupt the text of Scripture. Grotius, Nierembergius, the Dutch divines who criticiſed F. Simon, Menetrier, Baſnage, and ſome others, ſeem alſo to take the Canticles for a profane compoſition, on a footing with the love pieces of Catullus or Ovid. But this opinion is refuted by Michaelis, Majus, Whitſius, Nat. Alexander, Outrein, Francius, and others. Mr Whiſton's arguments have been particularly conſidered by Itchener, and alſo by Dr Gill. R. Akiba finds the book of Canticles more divine than the reſt: the whole world, according to this rabbin, is not worth that day when the Canticles was given to Iſrael; for, whereas all the hagiographers are holy, the Canticles is the holy of holies.

CANTIMARONS, or Catimarons, a kind of floats, or rafts, uſed by the inhabitants of the coaſt of Coromandel to go a fiſhing in, and to trade along the coaſt. They are made of three or four ſmall canoes, or trunks of trees dug hollow, and tied together with cacao ropes, with a triangular ſail in the middle, made of mats. The perſons who manage them are almoſt half in the water, there being only a place in the middle a little raiſed to hold their merchandiſe; which laſt particular is only to be underſtood of the trading cantimarons, and not of thoſe who go a-fiſhing.

CANTIN, Cape, a promontory of the coaſt of Morocco in Africa, ſituated in W. Long. 10. 2. N. Lat. 33. 9.

CANTING, a ſea phraſe, denotes the act of turning any thing about.

Canting *Language* or *Dialect*, is a myſterious ſort of jargon uſed by the gypſies, thieves, and ſtrolling beggars, to expreſs their ſentiments to each other, without being underſtood by the reſt of mankind. This dialect is not founded on any rules; yet even out of that irregularity many words ſeem to retain ſomething of ſcholarſhip; as *togeman*, a gown, from *toga* in the Latin; *pannam*, bread, from *panis;* *caſan*, cheeſe, from *caſeus*, &c. It is obſervable, that, even unknown to ourſelves, we have adopted ſome of their terms into our vulgar language; as *bite* and *bilk*, to cheat; *bounce*, to vapour; *bowſe*, ſtrong drink; *filch*, to ſteal; *flog*, to whip; *rig*, game or ridicule; *roaſt*, to rally; *rhino*, money. From the ſame ſource proceeds the words *ſham*, *banter*, *bubble*, *bully*, *ſharper*, *cutting*, *ſhuffling*, *palming*, &c. An anonymous author has given a canting dictionary, comprehending all the terms uſed by the ſeveral tribes of gypſies, beggars, ſhoplifters, highwaymen, foot-pads, and other clans of cheats and villains, with a collection of ſongs in the canting dialect: London, 1725, 8vo.

CANTIUM, in *Ancient Geography*, a promontory of Britain, literally denoting a headland: giving name to a territory called *Cantium*, now Kent; and to a people called *Cantii* (Cæſar), commended for their great humanity and politeneſs. The promontory now the North *Foreland*. Is is ſuppoſed that this was the firſt diſtrict in Britain which received a colony from the continent; and that it had frequently changed its maſters, by new colonies coming over from time to time, and driving the inhabitants further north. In the midſt of all theſe revolutions it ſtill retained its ancient name (which was ſo agreeable to its ſhape and ſituation), and gave the ſame name to all the ſucceſſive tribes by which it was inhabited. Thoſe who poſſeſſed it at the time of the firſt Roman invaſion were evidently of Belgic origin, and had come over ſo lately, that they differed in nothing from their countrymen on the continent. "The inhabitants of Kent (ſays Cæſar) are the moſt civilized of all the Britons, and differ but very little in their manners from the Gauls." This great reſemblance between the people of Kent and their neighbours on the continent, might be partly owing to the ſituation of their country, which being neareſt to the continent, was moſt frequented by ſtrangers from thence. It was this ſituation alſo which expoſed them to the firſt aſſaults of the Romans. For Cæſar, in both his expeditions into this iſland, landed in Kent; and therefore we may conclude, that the Cantii had a great ſhare in the vigorous oppoſition that was made to his landing, and in the ſeveral battles and ſkirmiſhes which were fought againſt him after his landing; particularly, they made a very bold, but unſucceſsful attempt, upon his naval camp. The Cantii did not make the ſame vigorous reſiſtance to the Romans on their next invaſion in the reign of Claudius. For Aulus Plautius, the Roman general in that expedition, traverſed their country without ſeeing an enemy; and as they now ſubmitted to the power of Rome without a ſtruggle, ſo they continued in a ſtate of quiet ſubmiſſion to it to the very laſt. The ſituation of Cantium occaſioned its being much frequented by the Romans, who generally took their way through it in their marches to and from the continent. Few places in Britain are more frequently mentioned by the Roman writers than Rutupium and Portus Rutupenſis, moſt probably Richborough and Stonar. Rutupium was the ſame in thoſe times that Dover is in ours; the uſual place of embarking for, and landing from, the continent. Before the final departure of the Romans out of Britain, Portus Dubris, now Dover, had become a conſiderable place, and a well frequented harbour, where the third iter of Antoninus ends, and from whence they often embarked for Gaul. Portus Lemanus, ſuppoſed to be Lime near Weſt Hythe, was alſo a noted ſeaport in theſe times, and the termination of the fourth iter of Antoninus. Durobrivæ and Durovernum, now Rocheſter and Canterbury, were both Roman towns and ſtations, and are often mentioned in the Itinerary and other books. Beſides theſe, there are ſeveral other Roman ſtations, towns, and ports in Cantiun, which need not to be particularly enumerated here. Cantium, in the moſt perfect ſtate of the Roman government, made a part of the province which was called *Flavia Cæsarienſis*.

CANTO, denotes a part or diviſion of a poem, anſwering to what is otherwiſe called a *book*. The word is Italian, where it properly ſignifies *song*. Taſſo, Arioſto, and ſeveral other Italians, have divided their longer or heroic poems into cantos. In imitation of them, Scarron has alſo divided his *Gigantomachia*, and Boileau his *Lutrin*, into chants or ſongs. The like uſage has been adopted by ſome Engliſh writers, as Butler, who divides his Hudibras, and Dr Garth his Diſpenſary, into cantos. A late tranſlator of part of Virgil's Æneid has even ſubdivided a book of Virgil into ſeveral cantos.

Canto, in the Italian muſic, ſignifies a *song*: hence *canto simplice* is where all the notes or figures are equal, and called alſo *canto sermo*; *canto ſigurato*, that where the figures are unequal, and expreſs different motions.

Canto alſo ſignifies the treble part of a ſong: hence *canto concertante*, the treble of the little chorus; *canto repieno*, the treble of the grand chorus, or that which ſings only now and then in particular places. *Canto* ſignifies the firſt treble, unleſs ſome other word be added to it, as *secondo*; in which caſe it denotes the ſecond treble.

CANTON, in *Geography*, denotes a ſmall diſtrict or country conſtituting a diſtinct government: ſuch are the cantons of Switzerland.

Canton, *Quang-tong*, or Koanton, one of the ſouthern provinces of China; bounded on the north-eaſt by Fokien, on the north by Kiang-ſi, on the weſt by Quang-ſi and the kingdom of Tonking, and everywhere elſe by the ſea. The country is diverſified with hills and plains, and the ſoil in general ſo fertile that it produces two crops annually. Beſides many of the fruits of Europe, and thoſe common in other parts of the Indies, the province of Canton produces ſome peculiar to itſelf. Abundance of valuable aromatic woods are alſo to be met with in this province, as well as eagle wood, ebony, &c.; and in the mineral kingdom the province furniſhes gold, precious ſtones, tin, quickſilver, and copper. Silk and ſugar are alſo cultivated here, and pearls are fiſhed up on the coaſts; ſo that every thing which can contribute to the pleaſure or convenience of life is to be met with in Canton. "One begins (ſays F. Premare) to have an idea of China, on entering the river Canton. Both ſides of it preſent large fields of rice which reſemble green meadows, and extend beyond the reach of ſight. They are interſected by an infinite number of ſmall canals, in ſuch a manner that the barks which paſs and repaſs in them ſeem at a diſtance, while the water which carries them is concealed, to glide along the graſs. Farther inland the country appears covered with trees, and cultivated along the valleys; and the whole ſcene is interſperſed with villages, rural ſeats, and ſuch a variety of delightful proſpects, that one is never tried of viewing them, and regrets to be obliged to paſs them ſo quickly.

All the coaſts of this province abound with fiſh, and furniſh vaſt numbers of crabs, oyſters, and tortoiſes of an immenſe ſize. The inhabitants keep a prodigious number of tame ducks, which they hatch in ovens or dunghills, though it does not appear that they borrowed this cuſtom from the Egyptians. The docility of theſe creatures exceeds what we ſhould be apt at firſt to imagine. The inhabitants load a number of ſmall barks with them, and carry them in flocks to feed on the ſea ſhore, where they find ſhrimps and other animals proper for their nouriſhment. But though the ducks from the different barks are thus unavoidably mixed together in the day time, they are eaſily collected by only beating on a baſon, on which they immediately collect themſelves into different flocks, and each returns to his proper bark.

In this province the Chineſe have alſo a method of preſerving not only the fleſh of the ducks in ſuch a manner that it loſes nothing of its original flavour, but their eggs alſo. The latter operation is performed by covering the eggs with a coat of clay mixed with ſalt. When mixed in this manner, it ſeems that the ſalt has the property of penetrating through the pores of the ſhell, and thus impregnating the ſubſtance in the egg, which it could not do by ſimple ſolution in water.

Canton, though it ſuffered much in the Chineſe wars, is at preſent one of the moſt flouriſhing provinces of the empire; and being at a great diſtance from court, its government is one of the moſt important. A great number of fortreſſes, many of which are cities provided with numerous garriſons, have been built along the coaſts for the ſuppreſſion of pirates and robbers; for which purpoſe alſo a certain number of troops are kept properly poſted in different parts of the province. It is divided into ten diſtricts, which contain as many cities of the firſt claſs, and 84 of the ſecond and third. The air in general is warm but healthy, and the people are very induſtrious. They poſſeſs in an eminent degree the talent of imitation; ſo that if they are only ſhown any European work, they can execute others like it with ſurpriſing exactneſs. The moſt remarkable cities in the province beſides Canton the capital are, 1. Chao-tcheou-fou, chiefly noted for a monaſtery of bonzes in its neighbourhood, to which the adjacent country belongs, and the origin of which is traced back for 800 or 900 years. It has under its juriſdiction ſix cities of the third claſs; near one of theſe grows a reed of which ſeveral inſtruments are made, which cannot be diſtinguiſhed from real ebony. The air of Chao-tcheou-fou, however, is unhealthy; and great numbers of the inhabitants are carried off annually by contagious diſtempers, which prevail from the middle of October to the beginning of December. 2. Kao-tcheou-fou, ſituated in a delightful and plentiful country. In the neighbourhood is found a ſingular kind of ſtone much reſembling marble, on which are natural repreſentations of rivers, mountains, landſcapes, and trees. Theſe ſtones are cut into ſlabs, and made into tables, &c. Crabs are alſo caught on the coaſts here, which very much reſemble thoſe of Europe; but, ſays M. Groſier, they have this ſingularity, that when taken out of the water, they become petrified without loſing any thing of their natural figure. 3. Kiun-tcheou-fou, the capital of the iſland of Hai-nan. See HAI-NAN.

CANTON, a large, populous, and wealthy city of China, capital of the province of that name, ſtands on the banks of the river Taa, or great river, which, near the city, is wide and ſpacious. The wall of the city is pretty high, and about ſix or ſeven miles in circumference, though not more than one third of the ground is occupied by buildings, the other parts being appropriated to pleaſure grounds or to fiſh ponds. The country is extremely pleaſant, and towards the eaſt hilly, ſo as to command a beautiful proſpect of the city and ſuburds, the compaſs of which, together, is about ten miles.

The buildings of Canton are in general low, conſiſting of one ſtory and a ground floor, which is covered with earth or red tiles in order to keep it cool; but the houſes of the moſt reſpectable merchants and mandarins are comparatively lofty and well built. In different parts of the city and ſuburbs are joſs houſes or temples, in which are placed the images worſhipped by the Chineſe: before whom are placed, at particular ſeaſons, a vaſt variety of ſweetmeats, oranges, great plenty of food ready dreſſed, and alſo incenſe, which is kept perpetually burning.

The ſtreets of Canton are long and narrow, paved with flat ſtones, adorned at intervals with triumphal arches, which have a pleaſing effect, and much crowded with people. On both ſides are ſhops as in London, appropriated to the ſale of different commodities; and a kind of awning is extended from houſe to houſe, which prevents the ſun's rays from incommoding either inhabitants or paſſengers. At the end of every ſtreet is a barrier, which, with the gates of the city, are ſhut in the evening. In China ſtreet, which is pretty long and conſiderably wider than the reſt, reſide merchants; whoſe trade, ſo far as reſpects china, lackered ware, fans, &c. is wholly confined to Europeans. Moſt of them ſpeak the foreign languages tolerably well, or at leaſt ſufficintly intelligible to tranſact buſineſs. Beſides theſe merchants, there is a company of twelve or thirteen, called the *Cohong*; who have an excluſive right by appointment from authority to purchaſe the cargoes from the different ſhips, and alſo to ſupply them with teas, raw ſilks, &c. in return. The eſtabliſhment of the Cohong, though injurious to private trade, is admirably well adapted for the ſecurity of the different companies with which they traffic; becauſe each individual becomes a guarantee for the whole; ſo that if one fail, the others conſider themſelves as reſponſible.

In Canton there are no carriages; all burdens are carried by porters acroſs their ſhoulders on bamboos; as are alſo the principal people in ſedan chairs, and the ladies always. The ſtreets of Canton may be traverſed from morning till evening without ſeeing a woman, thoſe excepted who are Tartars, and even theſe but very ſeldom.

On the wharf of the river, which is commodious and pleaſant, ſtand the factories of the different European nations, viz. the Dutch, French, Swedes, Danes, Engliſh, &c. In thoſe reſide the ſupercargoes belonging to their reſpective companies, who are appointed to diſpoſe of the cargoes brought to market; to ſupply the ſhips with others from Europe in return; and, during their abſence, to contract with the merchants for ſuch articles as may be judged neceſſary for the next fleet. Between the reſidents of the factories the moſt perfect cordiality ſubſiſts; in each a common and ſplendid table is kept at the company's expence, and viſits are reciprocally exchanged; ſo that nothing is wanting to make reſidence at Canton agreeable to an European, but the pleaſure naturally reſulting from the ſociety of women.

The ſide of the river next the city is covered with boats, which form a kind of town or ſtreets, in which live the poorer ſort of the Chineſe, or rather the deſcendants of the Tartars. Some of the men come on ſhore in the morning to their reſpective employments, and in thoſe ſampans, or boats which are not ſtationary, the women and alſo the men carry paſſengers from place to place in the ſame manner as is done by wherries on the Thames. On this river live many thouſand ſouls who never were permitted to come on ſhore; whoſe only habitation is their boat; in which they eat, drink, ſleep, carry on many occupations, keep ducks, &c. and occaſionally a hog.

The manufactures of Canton are principally carried on in the ſuburbs; though it has been frequently ſuppoſed that they were confined to the city; and this, by ſome writers, has been given as a reaſon why Europeans are not permitted to enter within the gates. But this is a miſtake; and perhaps the true reaſon for this very ſingular reſtraint is, that the houſes in which they keep their women are chiefly within the city.

At Wampoa, a large commodious place for anchorage, and which is about 12 or 14 miles from Canton, the European veſſels lie and unload their cargoes, which are tranſmitted by lighters to the factories; and by the ſame conveyance receive their reſpective freights. Between this place and the city are three hoppo, or cuſtomhouſes, at which the boats paſſing and repaſſing are obliged to ſtop, and undergo with their paſſengers an examination, in order to prevent ſmuggling. The lighters juſt mentioned, and alſo the captain's pinnace, are, however, excepted; the former having proper officers on board for the purpoſe, and the latter being narrowly watched and examined at the landing.

The weather at Canton is, in ſummer, extremely hot; and in the months of December, January, and February, cold: the country is nevertheleſs pleaſant and healthful, abounding with all the neceſſaries and delicacies of life, which may be procured on terms much cheaper than in Europe. The number of inhabitants has been eſtimated at one million; but later calculations have made the number conſiderably leſs. N. Lat. 23. 30. E. Long. 113. 20.

Canton, *John*, an ingenious natural philoſopher, was born at Stroud, in Glouceſterſhire, in 1718; and was placed, when young, under the care of a Mr Davis, of the ſame place, a very able mathematician, with whom, before he had attained the age of nine years, he had gone through both vulgar and decimal arithmetic. He then proceeded to the mathematics, and particularly to algebra and aſtronomy, wherein he had made a conſiderable progreſs, when his father took him from ſchool, and put him to learn his own buſineſs, which was that of a broad cloth weaver. This circumſtance was not able to damp his zeal for the acquiſition of knowledge. All his leiſure time was devoted to the aſſiduous cultivation of aſtronomical ſcience; and, by the help of the Caroline tables annexed to "Wing's Aſtronomy," he computed eclipſes of the moon and other phenomena. His acquaintance with that ſcience he applied likewiſe to the conſtructing of ſeveral kinds of dials. But the ſtudies of our young philoſopher being frequently purſued to very late hours, his father, fearing that they would injure his health, forbade him the uſe of a candle in his chamber any longer than for the purpoſe of going to bed, and would himſelf often ſee that his injunction was obeyed. The ſon's thirſt of knowledge was, however, ſo great, that it made him attempt to evade the prohibition, and to find means of ſecreting his light till the family had retired to reſt, when he roſe to proſecute undiſturbed his favourite purſuits. It was during this prohibition, and at theſe hours, that he computed, and cut upon ſtone, with no better an inſtrument than a common knife, the lines of a large upright ſun-dial, on which, beſides the hour of the day, was ſhown the riſing of the ſun, his place in the ecliptic, and ſome other particulars. When this was finiſhed, and made known to his father, he permitted it to be placed before the front of his houſe, where it excited the admiration of ſeveral gentlemen in the neighbourhood, and introduced young Mr Canton to their acquaintance, which was followed by the offer of the uſe of their libraries. In the library of one of theſe gentlemen, he found "Martin's Philoſophical Grammar," which was the firſt book that gave him a taſte for natural philoſophy. In the poſſeſſion of another gentleman, a few miles from Stroud, he firſt ſaw a pair of globes; an object that afforded him uncommon pleaſure, from the great eaſe with which he could ſolve thoſe problems he had hitherto been accuſtomed to compute. The dial was beautified a few years ago at the expence of the gentlemen at Stroud, ſeveral of whom had been his ſchool-fellows, and who continued ſtill to regard it as a very diſtinguiſhed performance. Among other perſons with whom he became acquainted in early life, was the late reverend and ingenious Dr Henry Miles of Tooting, a learned and reſpectable member of the royal ſociety, and of approved eminence in natural knowledge. This gentleman, perceiving that Mr Canton poſſeſſed abilities too promiſing to be confined within the narrow limits of a country town, prevailed on his father to permit him to come to London. Accordingly he arrived at the metropolis March 4. 1737, and reſided with Dr Miles at Tooting till the 6th of May following; when he articled himſelf for the term of five years, as a clerk to Mr Samuel Watkins, maſter of the academy in Spital-ſquare. In this ſituation, his ingenuity, diligence, and good conduct, were ſo well diſplayed, that on the expiration of his clerkſhip in May 1742, he was taken into partnerſhip with Mr Watkins for three years; which gentleman he afterwards ſucceeded in Spital-ſquare, and there continued during his whole life. In 1744, he married Penelope, the eldeſt daughter of Mr Thomas Colbrooke, and niece to James Colbrooke, Eſq. banker in London.

Towards the end of 1745, electricity, which ſeems early to have engaged Mr Canton's notice, received a very capital improvement by the diſcovery of the famous Leyden Phial. This event turned the thoughts of moſt of the philoſophers of Europe to that branch of natural philoſophy; and our author, who was one of the firſt to repeat and to purſue the experiment, found his aſſiduity and attention rewarded by many capital diſcoveries. Towards the end of 1749, he was concerned with his friend, the late Mr Benjamin Robins, in making experiments in order to determine to what height rockets may be made to aſcend, and at what diſtance their light may be ſeen. In 1750 was read at the Royal Society Mr Canton's "Method of making artificial magnets, without the uſe of, and yet far ſuperior to, any natural ones." This paper procured him the honour of being elected a member of the ſociety, and the preſent of their gold medal. The ſame year he was complimented with the degree of M. A. by the univerſity of Aberdeen; and, in 1751, was choſen one of the council of the Royal Society.

In 1752, our philoſopher was ſo fortunate as to be the firſt perſon in England, who, by attracting the electric fire from the clouds during a thunder ſtorm, verified Dr Franklin's hypotheſis of the ſimilarity of lightning and electricity. Next year, his paper entitled, "Electrical Experiments, with an attempt to account for their ſeveral Phenomena," was read at the Royal Society. In the ſame paper Mr Canton mentioned his having diſcovered, by a great number of experiments, that ſome clouds were in a poſitive, and ſome in a negative, ſtate of electricity. Dr Franklin, much about the ſame time, made the like diſcovery in America. This circumſtance, together with our author's conſtant defence of the doctor's hypotheſis, induced that excellent philoſopher, immediately on his arrival in England, to pay Mr Canton a viſit, and gave riſe to a friendſhip which ever after continued without interruption or diminution. In the "Lady's Diary, for 1756," our author anſwered the prize queſtion that had been propoſed in the preceding year. The queſtion was, " How can what we call the ſhooting of ſtars be beſt accounted for; what is the ſubſtance of this phenomenon; and in what ſtate of the amoſphere doth it moſt frequently ſhow itſelf ?" The ſolution, though anonymous, was ſo ſatisfactory to his friend, Mr Thomas Simſon, who then conducted that work, that he ſent Mr Canton the prize, accompanied with a note, in which he ſaid, he was ſure that he was not miſtaken in the author of it, as no one beſides, that he knew of, could have anſwered the queſtion. Our philoſopher's next communication to the public, was a letter in the " Gentleman's Magazine, for September 1759," on the electrical properties of the tourmalin, in which the laws of that wonderful ſtone are laid down in a very conciſe and elegant manner. On December 13th, in the ſame year, was read at the Royal Society, " An attempt to account for the regular diurnal variation of the Horizontal Magnetic Needle; and alſo for its irregular variation at the time of an Aurora Borealis." A complete year's obſervtaions of the diurnal variations of the needle are annexed to the paper. On Nov. 5. 1761, our author communicated to the Royal Society an account of the Tranſit of Venus, June 6. 1761, obſerved in Spital-ſquare. Mr Canton's next communication to the Society, was a letter addreſſed to Dr Benjamin Franklin, and read Feb. 4. 1762; containing ſome remarks on Mr Delaval's electrical experiments. On Dec. 16. in the ſame year, another curious addition was made by him to philoſophical knowledge, in a paper entitled, " Experiments to prove that water is not incompreſſible." Theſe experiments are a complete refutation of the famous Florentine experiments, which ſo many philoſophers have mentioned as a proof of the incompreſſibility of water. On St Andrew's day, 1763, our author was the third time elected one of the council of the Royal Society; and on Nov. 8. in the following year, were read before that learned body, his farther " Experiments and obſervations on the compreſſibility of water, and ſome other fluids." The eſtabliſhment of this fact, in oppoſition to the received opinion, formed on the haſty deciſion of the Florentine Academy, was thought to be deſerving of the ſociety's gold medal. It was accordingly moved for in the council of 1764; and, after ſeveral invidious delays, which terminated much to the honour of Mr Canton, it was preſented to him Nov. 30. 1766.

The next communication of our ingenious author to the Royal Society, which we ſhall take notice of in this place, was on Dec. 22. 1763, being " An eaſy method of making a Phoſphorus that will imbibe and emit light like the Bolognian ſtone; with experiments and obſervations." When he firſt ſhowed to Dr Franklin the inſtantaneous light acquired by ſome of this phoſphorus from the near diſcharge of an electrified bottle, the doctor immediately exclaimed, " And God ſaid, Let there be light, and there was light." The dean and chapter of St Paul's having, in a letter to the preſident, dated March 5. 1769, requeſted the opinion of the Royal Society relative to the beſt and moſt effectual method of fixing electrical conductors to preſerve that cathedral from damage by lightning, Mr Canton was one of the committee appointed to take the letter into conſideration, and to report their opinion upon it. The gentlemen joined with him in this buſineſs were, Dr Watſon, Dr Franklin, Mr Delaval, and Mr Wilſon. Their report was made on the 8th of June following; and the mode recommended by them has been carried into execution. The laſt paper of our author's, which was read before the Royal Society, was on Dec. 21. 1769; and contained " Experiments to prove that the Luminouſneſs of the Sea ariſes from the putrefaction of its animal ſubſtances." In the account now given of his communications to the public, we have chiefly confined ourſelves to ſuch as were the moſt important, and which threw new and diſtinguiſhed light on various objects in the philoſophical world. Beſides theſe he wrote a number of papers both in earlier and in later life, which appeared in ſeveral different publications, and particularly in the Gentleman's Magazine.

The cloſe and ſedentary life of Mr Canton, ariſing from an unremitted attention to the duties of his profeſſion, and to the proſecution of his philoſophical inquiries and experiments, probably contributed to ſhorten his days. The diſorder into which he fell, and which carried him off, was a dropſy. His death happened on March 22. 1772, in the 54th year of his age.

CANTONING, in the military art, is the allotting diſtinct and ſeparate quarters to each regiment; the town where they are quartered being divided into as many cantons as there are regiments.

CANTRED, or CANTRETH, ſignifies a hundred villages. It is a Britiſh word, compounded of the adjective *cant*, i. e. hundred; and *tref*, a town or village. In Wales ſome of the counties are divided into cantreds, as in England into hundreds.

CANTYRE, from *Cantierre*, ſignifying a " headland;" the ſouthern diviſion of the ſhire of Argyle in Scotland. It is a peninſula, ſtretching 27 miles from north to ſouth, and ſeven miles in breadth. It is moſtly plain, arable, and populous; inhabited promiſcuouſly by Highlanders and Lowlanders, the latter being invited to ſettle in this place by the Argyle family, that the lands might be the better cultivated. It gives the title of *marquis* to the duke, and is by Lochfyne divided from Argyle Proper. This loch is an inlet from the ſea, about 60 miles in length and four in breadth, celebrated for its herring fiſhery. There are many paltry villages in this country, but no town of any conſequence except Campbletown.

CANTYRE was granted to the houſe of Argyle after the ſuppreſſion of a rebellion of the Macdonalds of the Iſles (and it is ſuppoſed of this peninſula) in the beginning of the laſt century, and the grant was afterwards ratified by parliament. The ancient inhabitants were the Mac-donalds, Mac-eachrans, Mac-kays, and Mac-maths.

Mull of CANTYRE, the ſouth cape or promontory of the peninſula. There is here a lighthouſe 235 feet above the ſea at high water, ſituated on the rocks called the *Merchants*. Lat. 55. 22. Long. 5. 42. weſt of London. The ſound of Iſla from the lighthouſe bearing, by the compaſs, N. by E. diſtant 27 miles; the ſouth end of Iſla N. N. W. diſtant 25 miles; the north end of Rathlin iſland, N. W. by W. one half W.; the Maiden Rocks, S. by W. one half W. diſtant 14 miles; Copland light, S. by W. one half W. diſtant

diſtant 31 miles. The lanthorn is ſeen from N. N. E. 1-4th E. from S. by W. 1-4th W. and intermediate points of the compaſs N. of theſe two points.

CANTZ, a town of Sileſia in Germany. E. Long. 16. 36. N. Lat. 51. 6.

CANVAS, in commerce, a very clear unbleached cloth of hemp, or flax, wove regularly in little ſquares. It is uſed for working tapeſtry with the needle, by paſſing the threads of gold, ſilver, ſilk or wool, through the intervals or ſquares.

CANVAS is alſo a courſe cloth of hemp, unbleached, ſomewhat clear, which ſerves to cover women's ſtays, alſo to ſtiffen men's clothes, and to make ſome other of their wearing apparel, &c.

CANVAS is alſo uſed among the French for the model or firſt words whereon an air or piece of muſic is compoſed, and given to a poet to regulate and finiſh. The canvas of a ſong contains certain notes of the compoſer, which ſhow the poet the meaſure of the verſes he is to make. Thus Du Lot ſays, he has canvas for ten ſonnets againſt the Muſes.

CANVAS is alſo the name of a cloth made of hemp, and uſed for ſhips ſails.

CANVAS, among painters, is the cloth on which they uſually draw their pictures; the canvas being ſmoothed over with a ſlick ſtone, then ſized, and afterwards whited over, makes what the painters called their *primed cloth*, on which they draw their firſt ſketches with coal or chalk, and afterwards finiſh with colours.

CANULA, in *Surgery*, a tube made of different metals, principally of ſilver and lead, but ſometimes of iron.

They are introduced into hollow ulcers, in order to facilitate a diſcharge of pus or any other ſubſtance; or into wounds, either accidental or artificial, of the large cavities, as the thorax or abdomen: they are uſed in the operation of bronchotomy; and by ſome, after the cutting for the ſtone, as a drain for urine.

Other canulas are uſed for introducing cauteries, either actual or potential, into hollow parts, in order to guard the parts adjacent to that to be cauterized, from injury. They are of various figures; ſome being oval, ſome round, and others crooked.

CANUSIUM, in *Ancient Geography*, a town of Apulia, on the right or ſouth ſide of the Aufidus, to the weſt of Cannæ, whither the Romans fled after the defeat ſuſtained there. It was famous for its red ſhining wool; whence thoſe who wore clothes made of it were called *Canuſinati*. Now called CANOSA; which ſee.

CANUTE, the firſt Daniſh king of England after Ironſide. He married Emma widow of King Ethelred; and put to death ſeveral perſons of quality who ſtood in his way to the crown. Having thus ſettled his power in England, he made a voyage to his other kingdom of Denmark, in order to reſiſt the attacks of the king of Sweden; and he carried along with him a great body of the Engliſh under the command of the earl of Godwin. This nobleman had here an opportunity of performing a ſervice by which he both reconciled the king's mind to the Engliſh nation, and, gaining to himſelf the friendſhip of his ſovereign, laid the foundation of that immenſe fortune which he acquired to his family. He was ſtationed next the Swediſh camp; and obſerving a favourable opportunity which he was obliged ſuddenly to ſeize, he attacked the enemy in the night, drove them ſuddenly from their trenches, threw them into diſorder, purſued his advantage, and obtained a deciſive victory over them. Next morning, Canute, ſeeing the Engliſh camp entirely abandoned, imagined that theſe diſaffected troops had deſerted to the enemy; and he was agreeably ſurpriſed to find that they were at that time engaged in purſuit of the diſcomfited Swedes. He was ſo pleaſed with this ſucceſs, and the manner of obtaining it, that he beſtowed his daughter in marriage upon Godwin, and treated him ever after with the moſt entire confidence and regard.

In another voyage which he afterwards made to Denmark, Canute attacked Norway, and expelled the juſt but unwarlike Olaus from his kingdom, of which he kept poſſeſſion till the death of that prince. He had now by his conqueſts and valour attained the utmoſt height of his ambition; and, having leiſure from wars and intrigues, he felt the unſatisfactory nature of all human enjoyments: and, equally weary of the glory and turmoils of this life, he began to caſt his view towards that future exiſtence, which it is ſo natural for the human mind, whether ſatiated by proſperity, or diſguſted with adverſity, to make the object of its attention. Unfortunately the ſpirit which prevailed in that age gave a wrong direction to his devotion; and, inſtead of making atonement to thoſe whom he had formerly injured by his acts of violence, he entirely employed himſelf in thoſe exerciſes of piety, which the monks repreſented as moſt meritorious. He built churches; he endowed monaſteries; he enriched eccleſiaſtics; and he beſtowed revenues for the ſupport of chantries at Aſſington and other places, where he appointed prayers to be ſaid for the ſouls of thoſe who had there fallen in battle againſt him. He even undertook a pilgrimage to Rome, where he ſojourned a conſiderable time; and, beſides obtaining from the pope ſome privileges for the Engliſh ſchool erected there, he engaged all the princes through whoſe dominions he was obliged to paſs, to deſiſt from thoſe heavy impoſitions and tolls which they were accuſtomed to exact from the the Engliſh pilgrims. By this ſpirit of devotion, no leſs than by his equitable and politic adminiſtration, he gained in a good meaſure the affections of his ſubjects.

Canute, who was the greateſt and moſt powerful prince of his time, ſovereign of Denmark and Norway as well as of England, could not fail to meet with adulation from his courtiers; a tribute which is liberally paid even to the meaneſt and weakeſt of princes, Some of his flatterers breaking out one day in admiration of his grandeur, exclaimed that every thing was poſſible for him: upon which the monarch, it is ſaid, ordered a chair to be ſet on the ſea ſhore while the tide was making; and as the waters approached, he commanded them to retire, and obey the voice of him who was lord of the ocean. He feigned to ſit ſome time in expectation of their ſubmiſſion; but when the ſea ſtill advanced towards him, and began to waſh him with its billows, he turned to his courtiers, and remarked to them, That every creature in the univerſe was feeble and impotent, and that power reſided with one Being alone, in whoſe hands were all the elements of nature, who could ſay to the ocean, "Thus far ſhalt thou go, and no farther," and who could level with his nod the moſt towering piles of human pride and ambition. From that time, it is ſaid, he never would wear a crown. He died in the 20th year of his reign; and was interred at Wincheſter, in the old monaſtery.

CANZONE, in *Muſic*, ſignifies, in general, a ſong, where ſome little fugues are introduced; but it is ſometimes uſed for a ſort of Italian poem, uſually pretty long, to which muſic may be compoſed in the ſtyle of a cantata. If this term be added to a piece of inſtrumental muſic, it ſignifies much the ſame as cantata; if placed in any part of a ſonata, it implies the ſame meaning as *allegro*, and only denotes that the part to which it is prefixed is to be played or ſung in a briſk and lively manner.

CANZONETTA, a diminutive of canzone, denoting a little ſhort ſong. The canzonette Neapolitane has two ſtrains, each whereof is ſung twice over, as the vaudevilles of the French. The canzonette Siciliane is a ſpecies of jig, the meaſure whereof is uſually twelve eighths, and ſix eighths, and ſometimes both, as rondeaus.

CAORLO, a ſmall iſland in the gulf of Venice, on the coaſt of Friuli, 20 miles ſouth-weſt of Aquileia, ſubject to Venice. It has a town of the ſame name, with a biſhop's ſee.

CAOUTCHOUC, ELASTIC RESIN, or *India rubber*, a ſubſtance produced from the ſyringe tree of Cayenne and other parts of South America, and poſſeſſed of the moſt ſingular properties. No ſubſtance is yet known which is ſo pliable, and at the ſame time ſo elaſtic; and it is farther a matter of curioſity, as being capable of reſiſting the action of very powerful menſtrua. From the account of M. de la Condamine, we learn that this ſubſtance oozes out, under the form of a vegetable milk, from inciſions made in the tree; and that it is gathered chiefly in time of rain, becauſe, though it may be collected at all times, it flows then moſt abundantly. The means employed to inſpiſſate and indurate it, M. de la Borde ſays, are kept a profound ſecret. M. Bomare, and others, affirm, that it thickens and hardens gradually by being expoſed to the air; and as ſoon as it acquires a ſolid conſiſtence it manifeſts a very extraordinary degree of flexibility and elaſticity. Accordingly the Indians make boots of it which water cannot penetrate, and which, when ſmoked, have the appearance of real leather. Bottles are alſo made of it, to the necks of which are faſtened hollow reeds, ſo that the liquor contained in them may be ſquirted through the reeds or pipes by preſſure. One of theſe filled with water is always preſented to each of the gueſts at their entertainments, who never fail to make uſe of it before eating. This whimſical cuſtom led the Protugueſe in that country to call the tree that produces the reſin *pao di xirringa*; and hence the name of *ſeringat* is given both to the tree and to its reſinous production. Flambeaux, an inch and a half in diameter, and two feet long, are likewiſe made of this reſin, which give a beautiful light, have no bad ſmell, and burn twelve hours. A kind of cloth is alſo prepared from it, which the inhabitants of Quito apply to the ſame purpoſe as our oil cloth and ſail cloth. It is formed, in fine, by means of moulds, into a variety of figures for uſe and ornament; and the proceſs is ſaid to be thus:---The juice, which is obtained by inciſion, is ſpread over pieces of clay formed into the deſired ſhape; and as faſt as one layer is dry, another is added, till the veſſel be of the proper thickneſs: the whole is then held over a ſtrong ſmoke of vegetables on fire, whereby it hardens into the texture and appearance of leather; and, before the finiſhing, while yet ſoft, is capable of having any impreſſion made on the outſide, which remains for ever after. When the whole is done the inſide mould is picked out.

Since this reſin has been known in Europe, its chemical qualities and other intereſting properties have been very diligently inveſtigated. In particular, it has been endeavoured to diſcover ſome method of diſſolving it in ſuch a manner that it would aſſume different figures, with equal eaſe as when in its original ſtate fluid. In the memoirs of the Academy of Sciences for 1768, we have an account of ſeveral attempts for this purpoſe, and how it may be effected.—The ſtate of vegetable milk in which the caoutchouc reſin is found when it comes from the tree, led M. Macquer to imagine that it was compoſed of an oil and a watery matter. From its wanting aromatic flavour, from its little volatility, and from its being incapable of ſolution in ſpirit of wine, he concluded that the oil which entered its compoſition was not an eſſential, but a fatty, one. Hence he thought it probable that it paſſed from a fluid to a ſolid form by the evaporation of the watery part, and that the oily ſolvents would reduce it to a ſoft ſtate. The firſt trials he made for diſſolving it were with linſeed oil, eſſence of turpentine, and ſeveral others. But all he could obtain by means of theſe menſtrua was a viſcid ſubſtance incapable of being hardened, and totally void of elaſticity. The rectified eſſential oil of turpentine was employed ſeemingly with greater ſucceſs. To ſeparate from this menſtruum the caoutchouc which it had diſſolved, M. Macquer added ſpirit of wine; but the conſequence was, that part only of the oil united with the ſpirit; the reſt remaining obſtinately attached to the reſin which it had diſſolved, and thus preventing it from aſſuming a ſolid conſiſtence. The author next endeavoured to diſſolve it by means of heat in Papin's digeſter. But neither water, nor ſpirit of wine, although in this way capable of diſſolving the hardeſt bones, could produce any other effect upon it than to render it more firm than before. After this, he tried what effect the milky juice of other vegetables would have upon it. He uſed ſeveral kinds, particularly that of the fig. But, in this way, he could obtain no ſolution. From the great volatility of ether, he was next induced to try it as a menſtruum; and, for this purpoſe, he prepared ſome with great attention. The caoutchouc, cut into little bits, and put into a proper veſſel with as much ether as was ſufficient to cover it, was perfectly diſſolved without any other heat than that of the atmoſphere. This ſolution was tranſparent and of an amber colour. It ſtill preſerved the ſmell of ether, but mixed with the diſagreeable odour of the caoutchouc, and it is a little leſs fluid than pure ether. Upon its being thrown into water, no milky liquor was produced; but there aroſe to the ſurface a ſolid membrane which poſſeſſed the great elaſticity and other peculiar properties of the caoutchouc. He obſerves, however, that two pints of the beſt ether, obtained by rectifying eight or ten pints of the common ether by a gentle heat, muſt be uſed, in order to the ſucceſs of the operation.---

ration.—The diſtinguiſhing properties of this ſubſtance, viz. its ſolidity, flexibility, and elaſticity, and its quality of reſiſting the action of aqueous, ſpirituous, ſaline, oily, and other common ſolvents, render it extremely fit for the conſtruction of tubes, catheters, and other inſtruments, in which theſe properties are wanted. In order to form this reſin into ſmall tubes, M. Macquer prepared a ſolid cylindrical mould of wax, of the deſired ſize and ſhape; and then, dipping a pencil into the ethereal ſolution of the reſin, daubed the mould over with it, till he had covered it with a coat of reſin of a ſufficient thickneſs. The whole piece is then thrown into boiling water; by the heat of which the wax is ſoon melted, and riſes to the ſurface, leaving the reſinous tube completely formed behind.

Groſſart informs us, that he has ſucceeded very well in employing the eſſential oils of turpentine and lavender as a ſolvent for the elaſtic gum, and thus forming it into tubes, or giving it any ſhape that is wanted. When the elaſtic tube is prepared with oil of lavender, the latter may be ſeparated by immerſing the tube in alcohol, which charges itſelf with the oil, and becomes a good lavender water. Alcohol ſerves another purpoſe beſide taking up the eſſential oil. It accelerates very much the drying of caoutchouc inſtruments, which are thus formed. Oil of turpentine appeared always to have a kind of ſtickineſs; and the ſmell, which could not be got rid of by any means yet diſcovered, was another inconvenience.

Groſſart propoſes another ſolvent, which is eaſily procured, and is not liable to the inconvenience juſt mentioned. This ſolvent is *water*. “I conceive (ſays he) it will appear ſtrange to mention water as a ſolvent of elaſtic gum, that liquid having been always ſuppoſed to have no action upon it. I myſelf reſiſted the idea; but reflecting that ether, by being ſaturated with water, is the better enabled to act on caoutchouc, and that this gum, when plunged into boiling water becomes more tranſparent at the edges, I preſumed that this effect was not due ſimply to the dilatation of its volume by the heat. I thought that, at that temperature, ſome action might take place, and that a long-continued ebullition might produce more ſenſible effects. I was not diſappointed in my expectations, and one of thoſe tubes was prepared without any other ſolvent than water and heat. I proceeded in the ſame manner as with ether: the elaſtic gum dilates but very little in boiling water; it becomes whitiſh, but recovers its colour again by drying it in the air and light. It is ſufficiently prepared for uſe when it has been a quarter of an hour in boiling water: by this time its edges are ſometimes tranſparent. It is to be turned ſpirally round the mould, in the manner we deſcribed before, and replunged frequently into the boiling water, during the time that is employed in forming the tube, to the end that the edges may be diſpoſed to unite together. When the whole is bound with packthread, it is to be kept ſome hours in boiling water; after which it is to be dried, ſtill keeping on the binding.

“If we wiſh to be more certain that the connexion is perfect, the ſpiral may be doubled; but we muſt always avoid placing the exterior ſurfaces of the ſlips one upon the other, as thoſe ſurfaces are the parts which moſt reſiſt the action of ſolvents. This precaution is leſs neceſſary when ether is employed, on account of its great action upon the caoutchouc.

“It might be feared that the action of water upon caoutchouc would deprive us of the advantages which might otherwiſe be expected; but theſe fears will be removed, if we conſider that the affinities differ according to the temperatures; that it is only at a very high temperature that water exerciſes any ſenſible action upon caoutchouc. I can affirm, that at 120° of Reaumur's thermometer (302° of Fahrenheit) this affinity is not ſuch as that the water can give a liquid form to caoutchouc; and it does not appear that we have any thing to fear in practice from a combination between theſe two bodies, which, though it really is a true ſolution, does not take place in any ſenſible degree but at a high temperature. It is therefore at preſent eaſy to make of caoutchouc whatever inſtruments it may be advantageous to have of a flexible, ſupple, and elaſtic ſubſtance, which is impermeable to water at the temperature of our atmoſphere, and reſiſts the action of acids as well as that of moſt other ſolvents. As to the durability of theſe inſtruments, few ſubſtances promiſe more than this, becauſe it may be ſoldered afreſh in a damaged part. Any woven ſubſtance may be covered with it; it is only required that the ſubſtance ſhould be of a nature not to be acted upon during the preparation, either by ether or by boiling water; for theſe two agents are thoſe which appear to me to merit the preference. Artiſts will frequently find an advantage in employing ether, as it requires leſs time; ſo that a perſon may make, in a ſingle day, any tube he may have occaſion for. The expence of ether is very little, ſince it is needful only to diſpoſe the caoutchouc to adhere; and, being brought into that ſtate, the caoutchouc may be kept in a veſſel perfectly well cloſed. It would alſo diminiſh the expence of the ether, if, inſtead of waſhing it with a large quantity of water, there ſhould be added to it only as much water as it can take up.” *Annales de Chimie*, vol. xi. p. 149.

A reſin ſimilar to this was ſome years ago diſcovered by M. Poivre, in the Iſle of France; and there are various milky juices extracted from trees in America and elſewhere, which by previous mixtures and preparations are formed into an elaſtic reſin, but of an inferior quality to that of Cayenne; ſuch, for inſtance, are the juices obtained from the *Cecropia peltata*, the *Ficus religiosa*, and *Indica*, &c.

Of the genuine trees, thoſe growing along the banks of the river of the Amazons are deſcribed by M. Condamine as attaining a very great height, being at the ſame time perfectly ſtraight, and having no branches except at top, which is but ſmall, covering no more than a circumference of ten feet. Its leaves bear ſome reſemblance to thoſe of the *manioc*: they are green on the upper part, and white beneath. The ſeeds are three in number, and contained in a pod conſiſting of three cells, not unlike thoſe of the *ricinus* or *palma Chriſti*; and in each of them there is a kernel, which being ſtripped and boiled in water produces a thick oil or fat, anſwering the purpoſe of butter in the cookery of that country.

A method of diſſolving this elaſtic gum without ether, for the purpoſes of a varniſh or the like, is as follows: Take one pound of the ſpirit of turpentine, and a pound of the gum cut into very ſmall pieces; pour the turpentine into a long-necked matraſs, which muſt be placed in a ſand bath; throw in the gum, not all at once, but by little and little according as it is perceived to diſſolve: When it is entirely diſſolved, pour into the matraſs a pint of nut or linſeed oil, or oil of poppies, rendered deſiccative in the uſual manner with litharge: Then let the whole boil for a quarter of an hour, and the preparation is finiſhed. This would make an excellent varniſh for air balloons, were it not ſo expenſive on account of the price of the gum. —Another method, invented by Mr Baldwin, is as follows. Take any quantity of the caoutchouc, as two ounces avoirdupois: cut it into ſmall bits with a pair of ſciſſars. Put a ſtrong iron ladle (ſuch as plumbers or glaziers melt their lead in) over a common pit-coal or other fire. The fire muſt be gentle, glowing, and without ſmoke. When the ladle is hot, much below a red heat, put a ſingle bit into the ladle. If black ſmoke iſſues, it will preſently flame and diſappear; or it will evaporate without flame: the ladle is then too hot. When the ladle is leſs hot, put in a ſecond bit, which will produce a white ſmoke. This white ſmoke will continue during the operation, and evaporate the caoutchouc: therefore no time is to be loſt; but little bits are to be put in, a few at a time, till the whole are melted. It ſhould be continually and gently ſtirred with an iron or braſs ſpoon. Two pounds, or one quart, of the beſt drying oil (or of raw linſeed oil, which, together with a few drops of neats foot oil, has ſtood a month, or not ſo long, on a lump of quicklime, to make it more or leſs drying) is to be put into the melted caoutchouc, and ſtirred till hot: and the whole poured into a glazed veſſel, through a coarſe gauze, or fine ſieve. When ſettled and clear, which will be in a few minutes, it is fit for uſe, either hot or cold.

The Abbè Clavigero informs us, that the elaſtic gum is called by the Mexicans *Olin* or *Olli*, and by the Spaniards of that kingdom *Ule*: That it diſtils from the olquahuitl, which is a tree of moderate ſize; the trunk of which is ſmooth and yellowiſh, the leaves pretty large, the flowers white, and the fruit yellow and rather round, but angular; within which there are kernels as large as filberts, and white, but covered with a yellowiſh pellicle: That the kernel has a bitter taſte, and the fruit always grows attached to the bark of the tree: That when the trunk is cut, the ule which diſtils from it is white, liquid, and viſcous; afterwards it becomes yellow; and laſtly of a leaden colour, though rather blacker, which it always retains. The tree, he adds, is very common in the kingdom of Guatimala.

Different trees, it would appear, yield the elaſtic gum. Aublet, in his *Hiſtoirê des Plantes de la Guiane* (p. 871.), deſcribes the tree, the fruit, and manner of collecting the juice; but never ſaw the flower: he calls it, however, *Hevea Guianenſis*. In Jacquin's America, it is called *Echites Corymboſa*. The younger Linnæus, in his *Supplementum Plantarum* (p. 422), names it *Jatropha Elaſtica*; but acknowledges that he only gives it this name from the ſtructure of the fruit having moſt reſemblance to that genus, his dry ſpecies wanting the flowers.

Of the above gum, it is ſaid, the Chineſe make elaſtic rings for laſcivious purpoſes.—Among us it is uſed by ſurgeons for injecting liquids, and by painters for rubbing out black lead pencil marks, &c.

CAP, a part of dreſs made to cover the head, much in the figure thereof.

The uſe of caps and hats is referred to the year 1449, the firſt ſeen in theſe parts of the world being at the entry of Charles VII. into Rouen: from that time they began to take place of the hoods, or chaperoons, that had been uſed till then. When the cap was of velvet, they called it *mortier*; when of wool, ſimply *bonnet*. None but kings, princes, and knights, were allowed the uſe of the mortier. The cap was the head-dreſs of the clergy and graduates. Paſquier ſays, that it was anciently a part of the hood worn by the people of the robe; the ſkirts whereof being cut off as an encumbrance, left the round cap an eaſy commodious cover for the head; which round cap being afterwards aſſumed by the people, thoſe of the gown changed it for a ſquare one, firſt invented by a Frenchman, called Patrouillet: he adds, that the giving of the cap to the ſtudents in the univerſities, was to denote, that they had acquired full liberty, and were no longer ſubject to the rod of their ſuperiors; in imitation of the ancient Romans, who gave a *pileus*, or cap, to their ſlaves, in the ceremony of making them free: whence the proverb, *Vocare ſervos ad pileum*. Hence, alſo, on medals, the cap is the ſymbol of Liberty, whom they repreſent holding a cap in her right hand, by the point.

The Romans were many ages without any regular covering for the head: when either the rain or ſun was troubleſome, the lappet of the gown was thrown over the head; and hence it is that all the ancient ſtatues appear bareheaded, excepting ſometimes a wreath, or the like. And the ſame uſage obtained among the Greeks, where, at leaſt during the heroic age, no caps were known. The ſort of caps or covers of the head in uſe among the Romans, on divers occaſions, were the *pitra*, *pileus*, *cucullus*, *galerus*, and *palliolum*; the differences between which are often confounded by ancient as well as modern writers.

The French clergy wear a ſhallow kind of cap, called *calotte*, which only covers the top of the head, made of leather, ſatin, worſted, or other ſtuff. The red cap is a mark of dignity allowed only to thoſe who are raiſed to the cardinalate. The ſecular clergy are diſtinguiſhed by black leathern caps, the regulars by knit and worſted ones.

Churchmen, and the members of univerſities, ſtudents in law, phyſic, &c. as well as graduates, wear ſquare caps. In moſt univerſities doctors are diſtinguiſhed by peculiar caps, given them in aſſuming the doctorate. Wickliff calls the canons of his time *bifurcati*, from their caps. Paſquier obſerves, that, in his time, the caps worn by the churchmen, &c. were called ſquare caps; though, in effect, they were round yellow caps.

The Chineſe have not the uſe of the hat, like us; but wear a cap of a peculiar ſtructure, which the laws of civility will not allow them to put off: it is different for the different ſeaſons of the year: that uſed in ſummer is in form of a cone, ending at top in a point. It is made of a very beautiful kind of mat, much valued in that country, and lined with ſatin: to this is added, at top, a large lock of red ſilk, which falls all round as low as the bottom; ſo that, in walking, the ſilk fluctuating regularly on all ſides, makes a graceful appearance: ſometimes, inſtead of ſilk, they uſe a kind of bright red hair, the luſtre whereof no weather effaces. In winter they wear a pluſh cap, bordered with martlet's or fox's ſkin; as to the reſt, like thoſe for the ſummer. Theſe caps are frequently ſold for eight or ten crowns; but they are ſo ſhort, that the ears are expoſed.

The cap is ſometimes uſed as a mark of infamy; in Italy the Jews are diſtinguiſhed by a yellow cap; at Lucca by an orange one. In France, thoſe who had been bankrupts were obliged ever after to wear a green cap, to prevent people from being impoſed on in any future commerce. By ſeveral arrets in 1584, 1622, 1628, 1688, it was decreed, that if they were at any time found without their green cap, their protection ſhould be null, and their creditors empowered to caſt them into priſon: but the ſentence is not now executed.

Cap *of Maintenance*, one of the regalia, or ornaments of ſtate, belonging to the kings of England, before whom it was carried at the coronation and other great ſolemnities. Caps of maintenance are alſo carried before the mayors of the ſeveral cities in England.

Cap and Button, are two ſmall iſlands, lying in longitude 105° 48′ 30″ eaſt; and in latitude, the former 5° 58′ 30″, the latter 5° 49′ ſouth. They are thus deſcribed by Sir George Staunton.

"At a little diſtance they might be miſtaken for the remains of old caſtles, mouldering into heaps of ruins, with tall trees already growing upon the tops; but at a nearer view, they betrayed evident marks of a volcanic origin. Exploſions from ſubterraneous fires, produce, for the moſt part, hills of a regular ſhape, and terminating in truncated cones; but when from a ſubaqueous volcano eruptions are thrown up above the ſurface of the ſea, the materials, falling back into the water, are more irregularly diſperſed, and generally leave the ſides of the new creation naked and miſhapen, as in the inſtance of Amſterdam, and of thoſe ſmaller ſpots called, from ſome reſemblance in ſhape, the Cap and Button.

"In the Cap were found two caverns, running horizontally into the ſide of the rock; and in theſe were a number of thoſe birds neſts ſo much prized by the Chineſe epicures. They ſeemed to be compoſed of fine filaments cemented together by a tranſparent viſcous matter, not unlike what is left by the foam of the ſea upon ſtones alternately covered by the tide, or thoſe gelatinous animal ſubſtances found floating on every coaſt. The neſts adhere to each other, and to the ſides of the cavern, moſtly in rows, without any break or interruption. The birds that build theſe neſts are ſmall gray ſwallows, with bellies of a dirty white. They were flying about in conſiderable numbers; but they were ſo ſmall, and their flight ſo quick, that they eſcaped the ſhot fired at them. The ſame neſts are ſaid alſo to be found in deep caverns, at the foot of the higheſt mountains in the middle of Java, and at a diſtance from the ſea, from which the birds, it is thought, derive no materials, either for their food or the conſtruction of their neſts; as it does not appear probable they ſhould fly, in ſearch of either, over the intermediate mountains, which are very high, or againſt the boiſterous winds prevailing thereabouts. They feed on inſects, which they find hovering over ſtagnated pools between the mountains, and for catching which their wide-opening beaks are particularly adapted. They prepare their neſts from the beſt remnants of their food. Their greateſt enemy is the kite, who often intercepts them in their paſſage to and from the caverns, which are generally ſurrounded with rocks of gray limeſtone or white marble. The neſts are placed in horizontal rows at different depths, from 50 to 500 feet. The colour and value of the neſts depend on the quantity and quality of the inſects caught, and perhaps alſo on the ſituation where they are built. Their value is chiefly determined by the uniform fineneſs and delicacy of their texture; thoſe that are white and tranſparent being moſt eſteemed, and fetching often in China their weight in ſilver. Theſe neſts are a conſiderable object of traffic among the Javaneſe, and many are employed in it from their infancy. The birds having ſpent near two months in preparing their neſts, lay each two eggs, which are hatched in about fifteen days. When the young birds become fledged, it is thought time to ſeize upon their neſts, which is done regularly thrice a-year, and is effected by means of ladders of bamboo and reeds, by which the people deſcend into the cavern; but when it is very deep, rope ladders are preferred. This operation is attended with much danger; and ſeveral break their necks in the attempt. The inhabitants of the mountains generally employed in it begin always by ſacrificing a buffalo; which cuſtom is conſtantly obſerved by the Javaneſe on the eve of every extraordinary enterpriſe. They alſo pronounce ſome prayers, anoint themſelves with ſweet-ſcented oil, and ſmoke the entrance of the cavern with gum-benjamin. Near ſome of thoſe caverns a tutelar goddeſs is worſhipped, whoſe prieſt burns incenſe, and lays his protecting hands on every perſon preparing to deſcend into the cavern. A flambeau is carefully prepared at the ſame time, with a gum which exudes from a tree growing in the vicinity, and is not eaſily extinguiſhed by fixed air or ſubterraneous vapours. The ſwallow, which builds thoſe neſts, is deſcribed as not having its tail feathers marked with white ſpots, which is a character attributed to it by Linnæus; and it is poſſible that there are two ſpecies or varieties of the ſwallow, whoſe neſts are alike valuable †."

Cap, in ſhip building, a ſtrong thick block of wood, uſed to confine two maſts together, when one is erected at the head of the other in order to lengthen it. It is for this purpoſe furniſhed with two holes perpendicular to its length and breadth, and parallel to its thickneſs: one of theſe is ſquare, and the other round: the former being ſolidly fixed upon the upper end of the lower maſt, whilſt the latter receives the maſt employed to lengthen it, and ſecures it in this poſition.

CAPACIO, an epiſcopal town of Italy in the kingdom of Naples, and in the hither Principato. E. Long. 15. 18. N. Lat. 40. 40.

CAPACITY, in a general ſenſe, an aptitude or diſpoſition to hold or retain any thing.

Capacity, in *Geometry*, is the ſolid contents of any body;

† *Embaſſy to China.*

body; alſo our hollow meaſures for wine, beer, corn, ſalt, &c. are called *meaſures of capacity*.

CAPACITY, in *Law*, the ability of a man, or body politic, to give or take lands or other things, or ſue actions.

Our law allows the king two capacities; a natural, and a political: in the firſt, he may purchaſe lands to him and his heirs; in the ſecond, to him and his ſucceſſors. The clergy of the church of England have the like.

CAPARASON, or CAPARISON, the covering or clothing laid over a horſe; eſpecially a ſumpter horſe, or horſe of ſtate. The word is Spaniſh, being an augmentative of *cape*, *caput*, *head*,

Anciently the caparaſons were a kind of iron armour, wherewith horſes were covered in battle.

CAPE, in *Geography*, a high land running out with a point into the ſea, as Cape Nord, Cape Horn, the Cape of Good Hope, &c.

CAPE *Elk*. See CERVUS, MAMMALIA *Index*.

CAPE *Breton*. See BRETON.

CAPE *Coaſt Caſtle*. See COAST.

CAPE *of Good Hope*. See GOOD HOPE.

CAPE *Verd*. See VERD.

CAPELL, EDWARD, a gentleman well known by his indefatigable attention to the works of Shakeſpeare, was a native of the county of Suffolk, and received his education at the ſchool of St Edmund's Bury. In the dedication of his edition of Shakeſpeare, in 1768, to the duke of Grafton, he obſerves; that "his father and the grandfather of his grace, were friends, and to the patronage of the deceaſed nobleman he owed the leiſure which enabled him to beſtow the attention of 20 years on that work." The office which his grace beſtowed on Mr Capell was that of deputy-inſpector of the plays, to which a ſalary is annexed of 200l. a-year. So early as the year 1745, as Mr Capell himſelf informs us, ſhocked at the licentiouſneſs of Hanmer's plan, he firſt projected an edition of Shakeſpeare, of the ſtricteſt accuracy, to be collated and publiſhed in due time, *ex fide codicum*. He immediately proceeded to collect and compare the oldeſt and ſcarceſt copies; noting the original excellencies and defects of the rareſt quartos, and diſtinguiſhing the improvements or variations of the firſt, ſecond, and third folios: and after many years labour produced a very beautiful ſmall octavo, in 10 volumes, with an "Introduction." There is not, the authors of the Monthly Review obſerve, among the various publications of the preſent literary era, a more ſingular compoſition than that "Introduction." In ſtyle and manner it is more obſolete and antique than the age of which he treats. It is Lord Herbert of Cherbury, walking the new pavement in all the trappings of romance; but, like Lord Herbert, it diſplays many valuable qualities accompanying this air of evtravagance, much ſound ſenſe, and appropriate erudition. In the title-page of "Mr William Shakeſpeare, his Comedies, Hiſtories, and Tragedies," it was alſo announced and promulgated, "Whereunto will be added, in ſome other volumes, notes critical and explanatory, and a body of various readings entire." "The Introduction" likewiſe declared, that theſe "notes and various readings" would be accompanied with another work, diſcloſing the ſources from which Shakeſpeare "drew the greater part of his knowledge in mythological and claſſical matters, his fable, his hiſtory, and even the ſeeming peculiarities of his language---to which," ſays Mr Capell, "we have given for title, The School of Shakeſpeare." Nothing ſurely could be more properly conceived than ſuch deſigns; nor have we ever met with any thing better grounded on the ſubject of "the learning of Shakeſpeare," than what may be found in the long note to this part of Mr Capell's Introduction. It is more ſolid than even the popular "Eſſay" on this topic. Certain quaintneſſes of ſtyle, and peculiarities of printing and punctuation, attended the whole of this publication. The outline, however, was correct; and the critic, with unremitting toil, proceeded in his undertaking. But while he was diving into the claſſics of Caxton (to continue the Reviewers account), and working his way under ground, like the river Mole, in order to imerge with all his glories; while he was looking forward to his triumps, certain other active ſpirits went to work upon his plan; and, digging out the promiſed treaſures, laid them prematurely before the public, defeating the effect of our critic's diſcoveries by anticipation. Steevens, Malone, Farmer, Percy, Reed, and a whole hoſt of literary ferrets, burrowed into every hole and corner of the warren of modern antiquity, and overran all the country, whoſe map had been delineated by Edward Capell. Such a contingency nearly ſtaggered the ſteady and unſhaken perſeverance of our critic, at the very eve of the completion of his labours, and as his editor informs us---for, alas! at the end of near 40 years, the publication was poſthumous, and the critic himſelf no more!---he was almoſt determined to lay the work wholly aſide. He perſevered, however, by the encouragement of ſome noble and worthy perſons; and to ſuch their encouragement, and his perſeverance, the public was, in 1783, indebted for three large volumes in 4to, under the title of "Notes and various readings of Shakeſpeare; together with the School of Shakepeare, or Extracts from divers Engliſh Books, that were in print in the Author's time; evidently ſhowing from whence his ſeveral Fables were taken, and ſome parcel of his Dialogue. Alſo farther extracts, which contribute to a due underſtanding of his Writings, or give a light to the Hiſtory of his Life, or to the Dramatic Hiſtory of his Time. By Edw. Capell."---Beſides the works already mentioned, Mr Capell was the editor of a volume of ancient poems called "Proluſions;" and the alteration of "Anthony and Cleopatra," as acted at Drury Lane in 1758. He died January 24. 1781.

CAPELLA, in *Aſtronomy*, a bright fixed ſtar in the left ſhoulder of the conſtellation Auriga.

CAPELLE, a town of France, in Picardy, and in the Tierache, eight miles from Guiſe. It was taken by the Spaniards in 1636; but retaken the year after. E. Long. 3. 59. N. Lat. 49. 58.

CAPELLETS. See FARRIERY *Index*.

CAPELLUS, LEWIS, an eminent French Proteſtand divine, born at Sedan in Champagne about the year 1579. He was the author of ſome learned works: but is chiefly known from the controverſy he engaged in with the younger Buxtorf concerning the antiquity of Hebrew points, which Capellus undertook to diſprove. His *Critica Sacra* was alſo an elaborate work, and excited ſome diſputes. He died in 1658, having made an abridgement of his life in his work *De gente Capellori*.

CAPER. See CAPPARIS, BOTANY *Index*.

CAPER alſo denotes a veſſel uſed by the Dutch for cruiſing and taking prizes from the enemy; in which ſenſe, caper amounts to the ſame with privateer. Capers are commonly double officered, and crowded with hands even beyond the rates of ſhips of war, becauſe the thing chiefly in view is boarding the enemies.

CAPERNAUM, a city celebrated in the Goſpels, being the place where Jeſus uſually reſided during the time of his miniſtry. This city is nowhere mentioned in the Old Teſtament under this or any other name like it; and therefore it is not improbable that it was one of thoſe towns which the Jews built after their return from the Babyloniſh captivity. It ſtood on the ſea coaſt, i. e. on the coaſt of the ſea of Galilee, in the borders of Zebulon and Nephtalim (Mat. iv. 15.), and conſequently towards the upper part thereof. It took its name no doubt from an adjacent ſpring, of great repute for its clear and limpid water; and which, according to Joſephus, was by the natives called *Capernaum*. As this ſpring might be ſome inducement to the building the town in the place where it ſtood, ſo its being a convenient wafting place from Galilee to any part on the other ſide of the ſea, might be ſome motive to our Lord for his moving from Nazareth, and making this the place of his moſt conſtant reſidence. Upon this account Capernaum was highly honoured, and ſaid by our Lord himſelf to be *exalted unto heaven;* but becauſe it made no right uſe of this ſignal favour, it drew from him the ſevere denunciation, that it ſhould *be brought down to hell* (Matt. xi. 23.), which has certainly been verified: for, as Dr Wells obſerves, ſo far is it from being the metropolis of all Galilee, as it once was, that it conſiſted long ſince of no more than ſix poor fiſhermen's cottages, and may perhaps be now totally deſolate.

CAPEROLANS, a congregation of religious in Italy, ſo called from Peter Caperole their founder, in the 15th century.

The Milaneſe and Venetians being at war, the enmity occaſioned thereby ſpread itſelf to the very cloiſters. The ſuperiors of the province of Milan, of minor brothers, which extended itſelf as far as the territories of the republic of Venice, carried it ſo haughtily over the Venetians, that thoſe of the convent of Breſcia reſolved to ſhake off a yoke which was grown inſupportable to them. The ſuperiors, informed of this, expelled out of the province thoſe whom they conſidered as the authors of this deſign; the principal of whom were Peter Caperole, Matthew de Tharvillo, and Bouaventure of Breſcia. Peter Caperole, a man of an enterpriſing genius, found means to ſeparate the convents of Breſcia, Bergamo, and Cremona, from the province of Milan, and ſubject them to the conventuals. This occaſioned a law-ſuit between the vicar-general and theſe convents, which was determined in favour of the latter; and theſe convents, in 1475, by the authority of Pope Sixtus IV. were erected into a diſtinct vicarate, under the title of that of *Breſcia*. This not ſatisfying the ambition of Caperole, he obtained, by the interpoſition of the doge of Venice, that this vicarate might be erected into a congregation, which was called from him *Caperolans*. This congregation ſtill ſubſiſts in Italy, and is compoſed of 24 convents, ſituated in Breſcia, Bergamo, and Cremaſco.

CAPEQUIN, a town of Ireland, in the county of Waterford, and province of Munſter, ſituated on the river Blackwater. W. Long. 7. 50. N. Lat. 52. 5.

CAPESTAN, a town of France, in Lower Languedoc, in the dioceſe of Narbonne, and near the royal canal. E. Long. 3. 5. N. Lat. 43. 35.

CAPH, a Jewiſh meaſure of capacity for things, eſtimated by Kimchi at the 30th part of the log, by Arbuthnot at the 16th part of the hin or 32d of the ſeah, amounting to five-eighths of an Engliſh pint. The caph does not occur in Scripture as the name of any meaſure.

CAPHAR, a duty which the Turks raiſed on the Chriſtians who carry or ſend merchandiſes from Aleppo to Jeruſalem and other places in Syria.

This duty of caphar was firſt impoſed by the Chriſtians themſelves, when they were in poſſeſſion of the Holy Land, for the maintenance of the troops which were planted in difficult paſſes to obſerve the Arabs and prevent their incurſions. It is ſtill continued, and much increaſed by the Turks, under pretence of defending the Chriſtians againſt the Arabs; with whom, nevertheleſs, they keep a ſecret intelligence, favouring their excurſions and plunders.

CAPHTOR, in *Ancient Geography*, a town or diſtrict of Higher Egypt: and hence the people called *Caphtorim* or *Caphtorei*.---Caphtor is an iſland of Egypt; Ai Caphtor, (Jeremiah); probably one of thoſe in the Nile. Dr Wells ſuppoſes it to be Coptos, which ſtood in a ſmall iſland. Thence came the *Caphtorim* or *Caphtoraei*, in Paleſtine; who with the Philiſtines conſpired to extirpate the Hevaei; and whoſe name was ſwallowed up in that of the Philiſtines.

CAPI-AGA, or CAPI-*Agaſſi*, a Turkiſh officer who is governor of the gates of the ſeraglio, or grand-maſter of the ſeraglio.

The capi-aga is the firſt dignity among the white eunuchs: he is always near the perſon of the grand ſignior: he introduces ambaſſadors to their audience: nobody enters or goes out of the grand ſignior's apartment but by his means. His office gives him the privilege of wearing the turban in the ſeraglio, and of going everywhere on horſeback. He accompanies the grand ſignior to the apartment of the ſultanas, but ſtops at the door without entering. His appointment is very moderate; the grand ſignior bears the expence of his table, and allows him at the rate of about ſixty French livres per day; but his office brings him in abundance of preſents; no affair of conſequence coming to the emperor's knowledge without paſſing through his hand. The capi-aga cannot be baſhaw when he quits his poſt.

CAPIAS, in *Law*, a writ of two ſorts; one before judgment in an action, and the other after. That before judgment is called *capias ad reſpondendum*, where an original is iſſued out, to take the defendant, and make him anſwer the plaintiff. That after judgment is of divers kinds; as,

CAPIAS *ad Satiſfaciendum*, a writ of execution that iſſues on a judgment obtained, and lies where any perſon recovers in a perſonal action, as for debt, damages, &

&c. in which caſes this writ iſſues to the ſheriff, commanding him to take the body of him againſt whom the debt is recovered, who is to be kept in priſon till he makes ſatisfaction.

Capias *Pro Fine* is a writ lying where a perſon is fined to the king, for ſome offence committed againſt a ſtatute, and he does not diſcharge the fine according to the judgment; therefore his body ſhall be taken by this writ, and committed to gaol till the fine is paid.

Capias *Utlegatum*, a writ which lies againſt any one outlawed, upon any action perſonal or criminal, by which the ſheriff is ordered to apprehend the party outlawed, for not appearing on the exigent, and keep him in ſafe cuſtody till the day of return, when he is ordered to preſent him to the court, to be there farther ordered for his contempt.

Capias *in Withernam*, a writ that lies for cattle *in withernam*: that is, where a diſtreſs taken is driven out of the county, ſo that the ſheriff cannot make deliverance upon a replevin; then this writ iſſues, commanding the ſheriff to take as many beaſts of the diſtrainer, &c.

CAPIGI, a porter or doorkeeper of the Turkiſh ſeraglio. There are about five hundered *capigis* or porters in the ſeraglio, divided into two companies; one conſiſting of three hundred, under a chief called *Capigi-Baſſa*, who has a ſtipend of three ducats per day; the other conſiſts of two hundred, diſtinguiſhed by the name of *Cucciapigi*, and their chief *Cuccicapigi-Baſſa*, who has two ducats. The capigis have from ſeven to fifteen aſpers per day; ſome more, others leſs. Their buſineſs is to aſſiſt the janizaries in the guard of the firſt and ſecond gates of the ſeraglio; ſometimes all together; as when the Turk holds a general council, receives an ambaſſador, or goes to the moſque; and ſometimes only in part; being ranged on either ſide to prevent people entering with arms, any tumults being made, &c. The word, in its original, ſignifies, *gate*.

CAPILLAMENT, in a general ſenſe, ſignifies a hair: whence the word is applied to ſeveral things, which on account of their length or their fineneſs reſemble hairs: as,

Capillaments *of the Nerves*, in *Anatomy*, the fine fibres or filaments whereof the nerves are compoſed.

CAPILLARY, in a general ſenſe, an appellation given to things on account of their extreme fineneſs or reſembling hair.

Capillary *Tubes*, in *Phyſics*, are ſmall pipes of glaſs, whoſe canals are extremely narrow, their diameter being only a half, a third, or a fourth of a line.

The aſcent of water, &c. in capillary tubes, is a phenomenon that has long embarraſſed the philoſophers; for let one end of a glaſs tube open at both extremities be immerged in water, the liquor within the tube will riſe to a conſiderable height above the external ſurface: or if two or more tubes are immerged in the ſame fluid, one a capillary tube, and the other of a larger bore, the fluid will aſcend higher in the former than in the latter; and this will be in a reciprocal ratio of the diameters of the tubes.

In order to account for this phenomenon, it will be neceſſary firſt to premiſe, that the attraction between the particles of glaſs and water is greater than the attraction between the particles of water themſelves: for if a glaſs tube be placed in a poſition parallel to the horizon, and a drop of water be applied to the under ſide of the tube, it will adhere to it: nor will it fall from the glaſs till its bulk and gravity are ſo far increaſed, as to overcome the attraction of the glaſs. Hence it is eaſy to conceive how ſenſibly ſuch a power muſt act on the ſurface of a fluid, not viſcid, as water, contained within the ſmall cavity or bore of a glaſs tube; as alſo that it will be proportionably ſtronger as the diameter of the bore is ſmaller; for it will be evident that the efficacy of the power is in the inverſe proportion of the diameter, when it is conſidered, that ſuch particles only as are in contact with the fluid, and thoſe immediately above the ſurface, can effect it.

Now theſe particles form a periphery contiguous to the ſurface, the upper part of which attracts and raiſes the ſurface, while the lower part, which is in contact with it, ſupports it: ſo that neither the thickneſs nor length of the tube is of any conſequence here; the periphery of particles only, which is always proportionable to the diameter of the bore, is the only acting power. The quantity of the fluid raiſed will therefore be as the ſurface of the bore which it fills, that is, as the diameter; for otherwiſe the effect would not be proportional to the cauſe, ſince the quantities are always as the ratio of the diameters; the heights therefore to which the fluids will riſe in different tubes, will be inverſely as the diameters.

Some doubt whether the law holds throughout, of the aſcent of the fluid being always higher as the tube is ſmaller: Dr Hook's experiments, with tubes almoſt as fine as cobwebs, ſeem to ſhow the contrary. The water in theſe, he obſerves, did not riſe ſo high as one would have expected. The higheſt he ever found it, was at 21 inches above the level of the water in the baſon; which is much ſhort of what it ought to have been by the law above mentioned. See Cohesion.

Capillary *Veſſels*. Many ſmall veſſels of animal bodies have been diſcovered by the modern invention of injecting the veſſels of animals with a coloured fluid, which upon cooling grows hard. But though moſt anatomiſts know the manner of filling the large trunks, few are acquainted with the art of filling the capillaries. Dr Monro, in the Medical Eſſays, has given what after many trials he has found moſt ſucceſsful. See Injection.

CAPILLUS veneris. See Adiantum, Botany *Index*.

CAPILUPI, or Capilupus, Camillus, a native of Mantua in the 16th century. He wrote a book, entitled, *The Stratagem*; in which he relates not only what was perpetrated at Paris during the maſſacre on St Bartholomew's day, but alſo the artful preparations which preceded that horrid maſſacre. It is, however, blended with a great number of falſities.

Capilupi, *Lœlius*, an Italian poet, brother to the former, made himſelf famous by ſome Centos of Virgil. The manner in which he applied Virgil's expreſſions to repreſent things which the poet never dreamt of, is admired. His Cento againſt women is very ingenious, but too ſatirical. The poems of Capilupi are inſerted in the *Deliciæ Poetarum Italorum*.

CAPISCOLUS, or Capischolus, in eccleſiaſtical writers, denotes a dignitary in certain cathedrals, who had the ſuperintendency of the choir, or band of muſic, anſwering to what in other churches is called *chanter* or *precentor*. The word is alſo written *cabiscolus*, and *caputscholæ*, q. d. the head of the ſchool, or band of music.

The capiſcolus is alſo called *scolasticus*, as having the inſtruction of the young clerks and choriſters, how to perform their duty.

CAPITA, Distribution by, in *Law*, ſignifies the appointing to every man an equal ſhare of a perſonal eſtate; when all the claimants claim in their own rights, as in equal degrees of kindred, and not *jure repreſentationis*.

Capital, *Succeſſion by*, where the claimants are next in degree to the anceſtor, in their own right, and not by right of repreſentation.

CAPITAL, of the Latin *caput* "the head," is uſed, on various occaſions, to expreſs the relation of a head, chief, or principal: thus,

Capital *City*, in *Geography*, denotes the principal city of a kingdom, ſtate, or province.

Capital *Stock*, among merchants, bankers, and traders, ſignifies the ſum of money which individuals bring to make up the common ſtock of a partnerſhip when it is firſt formed. It is alſo ſaid of the ſtock which a merchant at firſt puts into trade for his account. It likewiſe ſignifies the fund of a trading company or corporation, in which ſenſe the word ſtock is generally added to it. Thus we ſay, the capital ſtock of the bank, &c. The word capital is oppoſed to that of profit or gain, though the profit often increaſes the capital, and becomes of itſelf part of the capital, when joined with the former.

Capital *Crime*, ſuch a one as ſubjects the criminal to capital puniſhment, that is, to loſs of life. *

* See *Crime* and *Puniſhment*.

Capital *Picture*, in *Painting*, denotes one of the fineſt and moſt excellent pieces of any celebrated maſter.

Capital *Letters*, in *Printing*, large or initial letters, wherein titles, &c. are compoſed; with which all periods, verſes, &c. commence; and wherewith alſo all proper names of men, kingdoms, nations, &c. begin. The practice which, for ſome time, obtained among our printers, of beginning every ſubſtantive with a capital, is now juſtly fallen into diſrepute; being a manifeſt perverſion of the deſign of capitals, as well as an offence againſt beauty and diſtinctneſs.

Capital, in *Architecture*, the uppermoſt part of a column or pilaſter, ſerving as the head or crowning, and placed immediately over the ſhaft, and under the entablature. See Architecture.

CAPITANA, or Captain *Galley*, the chief or principal galley of a ſtate, not dignified with the title of a kingdom. The capitana was anciently the denomination of the chief galley of France, which the commander went on board of. But ſince the ſuppreſſion of the office of capitain general of the galleys in 1669, they have no capitana, but the firſt galley is called *reale*, and the ſecond *parone*.

CAPITANATA, one of the 12 provinces of the kingdom of Naples, in Italy, bounded on the north by the gulf of Venice, on the eaſt by the Terra di Bari, on the ſouth by the Baſilicata and the Farther Principato, and on the weſt by the county di Moliſe and a ſmall part of Hither Abruzzo. It is a level country, without trees; the ſoil ſandy, the air hot: the land, however, near the rivers, is fertile in paſtures. The capital town is Manfredonia.

CAPITANEATE, in a general ſenſe, the ſame with capitania. Capitaneates, in Pruſſia, are a kind of noble feuds or eſtates, which, beſides their revenue, raiſe their owners to the rank of nobility. They are otherwiſe called *starosties*.

CAPITANEI, or Catanei, in Italy, was a denomination given to all the dukes, marquiſes, and counts, who were called *capitanei regis*. The ſame appellation was alſo given to perſons of inferior rank who were inveſted with fees, formerly diſtinguiſhed by the appellation *valasores majores*.

CAPITANEUS, in ancient law writers, denotes a tenant in capite or chief.

Capitaneus, *Eccleſiæ*, the ſame with advocate.

CAPITANIA, in *Geography*, an appellation given to the 12 governments eſtabliſhed by the Portugueſe in the Braſils.

CAPITATION, a tax or impoſition raiſed on each perſon, in proportion to his labour, induſtry, office, rank, &c. It is a very ancient kind of tribute. The Latins call it *tributum*, by which taxes on perſons are diſtinguiſhed from taxes on merchandiſe, which were called *vectigalia*.

Capitations are never practiſed among us but in exigencies of ſtate. In France the capitation was introduced by Louis XIV. in 1695; and is a tax very different from the *taille*, being levied from all perſons, whether they be ſubject to the taille or not. The clergy pay no capitation, but the princes of the blood are not exempted from it.

CAPITE, in law, (from *caput*, i. e. *rex*; whence *tenere in capite*, is to hold of the *king*, the *head* or lord paramount of all the lands in the kingdom): An ancient tenure of land, held immediately of the king, as of the crown, either by knight's ſervice or by ſoccage. It is now aboliſhed. See Tenure.

Capite *Cenſi*, in antiquity, the loweſt rank of Roman citizens, who in public taxes were rated the leaſt of all, being ſuch as never were worth above 365 aſſes. They were ſuppoſed to have been thus called, becauſe they were rather counted and marſhalled by their heads than by their eſtates. The *capite cenſi* made part of the ſixth claſs of citizens, being below the *proletarii*, who formed the other moiety of that claſs. They were not enrolled in the army, as being judged not able to ſupport the expence of war; for in thoſe days the ſoldiers maintained themſelves. It does not appear that before Caius Marius any of the Roman generals liſted the *capite cenſi* in their armies.

CAPITOL, Capitolium, in *Antiquity*, a famous fort or caſtle, on the Mons Capitolinus at Rome, wherein was a temple dedicated to Jupiter, thence alſo denominated *Capitolinus*, in which the ſenate anciently aſſembled; and which ſtill ſerves as the city-hall, or townhouſe, for the meeting of the conſervators of the Roman people.—It had its name *capitol*, from *caput*, "a man's head," ſaid to have been found freſh, and yet bleeding, upon digging the foundation of the temple built in honour of Jupiter. Arnobius adds, that the man's name was *Tolus*, whence *caput tolium*. The firſt foundations of the capitol were laid by Tarquin the Elder, in the year of Rome 139. His ſucceſſor Servius raiſed the walls; and Tarquin the Proud finiſhed it in the year 221. But it was not conſecrated till the third year after the expulſion of the kings, and eſtabliſhment of the conſulate. The ceremony of the dedication of the temple was performed by the conſul Horatius in 246.

The capitol conſiſted of three parts; a nave ſacred to Jupiter, and two wings, the one conſecrated to Juno, the other to Minerva: it was aſcended to by ſtairs; the frontiſpiece and ſides were ſurrounded with galleries, in which thoſe who were honoured with triumphs entertained the ſenate at a magnificent banquet, after the ſacrifice had been offered to the gods.

Both the inſide and outſide were enriched with an infinity of ornaments, the moſt diſtinguiſhed of which was the ſtatue of Jupiter with his golden thunderbolt, his ſceptre, and crown. In the capitol alſo were a temple to Jupiter the Guardian, and another to Juno, with the mint; and on the deſcent of the hill was the temple of Concord. This beautiful edifice contained the moſt ſacred depoſites of religion, ſuch as the ancilia, the books of the Sibyls, &c.

The capitol was burnt under Vitellius, and rebuilt under Veſpaſian. It was burnt a ſecond time by lightning under Titus, and reſtored by Domitian.

Anciently the name *capitol* was likewiſe applied to all the principal temples in moſt of the colonies throughout the Roman empire; as at Conſtantinople, Jeruſalem, Carthage, Ravenna, Capua, &c.—That of Thoulouſe has given the name of *capitouls* to the echevins or ſheriffs.

CAPITOLINE GAMES, annual games inſtituted by Camillus, in honour of Jupiter Capitolinus, and in commemoration of the capitol's not being taken by the Gauls. Plutarch tells us that a part of the ceremony conſiſted in the public criers putting up the Hetrurians to ſale by auction: they alſo took an old man, and tying a golden bulla about his neck, expoſed him to the public deriſion. Feſtus ſays they alſo dreſſed him in a pretexta.—There was another kind of Capitoline games, inſtituted by Domitian, wherein there were rewards and crowns beſtowed on the poets, champions, orators, hiſtorians, and muſicians. Theſe laſt Capitoline games were celebrated every five years, and became ſo famous, that, inſtead of calculating time by luſtra, they began to count by Capitoline games, as the Greeks did by Olympiads. It appears, however, that this cuſtom was not of long continuance.

CAPITOLINUS, JULIUS, an hiſtorian in the beginning of the fourth age under Diocleſian, to whom he inſcribed the Lives of Verus, Antoninus Pius, Clodius Balbinus, Macrinus, the Maximins, and the Gordians. He wrote other lives, which are moſt of them loſt.

CAPITOUL, or CAPITOL, an appellation given to the chief magiſtrates of Thoulouſe, who have the adminiſtration of juſtice and policy both civil and mercantile in the city. The capitouls at Thoulouſe are much the ſame with the echevins at Paris, and with the conſuls, bailiffs, burgomaſters, mayors, and aldermen, &c. in other cities. In ancient acts they are called *conſules. capitularii*, or *capitolini*, and their body *capitulum*. From this laſt come the words *capitularii* and *capitouls*. The appellative *capitolini* aroſe hence, that they have the charge and cuſtody of the townhouſe, which was anciently called *capitol*.

The office laſts only one year, and ennobles the bearers. In ſome ancient acts they are called *capitulum nobilium Toloſæ*. Thoſe who have borne it ſtyle themſelves afterwards burgeſſes. They are called to all general councils, and have the *jus imaginum*; that is, when the year of their adminiſtration is expired, their pictures are drawn in the townhouſe; a cuſtom which they have retained from the ancient Romans, as may be ſeen in Sigonius.

CAPITULATE, an appellation given to the ſeveral quarters or diſtricts of the city of Thoulouse, each under the direction of a capitoul: much like the wards of London, under their aldermen. Thoulouſe is now divided into eight *capitoulates*, or quarters, which are ſubdivided into *moulans*, each of which has its tithing-man, whoſe buſineſs is to inform the capitoul of what paſſes in his tithing, and to inform the inhabitants of the tithing of the orders of the capitoul.

CAPITULAR, or CAPITULARE, denotes an act paſſed in a chapter, either of knights, canons, or religious.

The capitularia or capitulars of Charlemagne, Charles the Bald, &c. are the laws, both eccleſiaſtical and civil, made by thoſe emperors in the general councils or aſſemblies of the people; which was the way in which the conſtitutions of moſt of the ancient princes were made; each perſon preſent, though a plebeian, ſetting his hand to them.

Some diſtinguiſh theſe from laws; and ſay, they were only ſupplements to laws. They had their name, *capitulars*, becauſe divided into capitula, chapters, or ſections. In theſe capitulars did the whole French juriſprudence anciently conſiſt. In proceſs of time, the name was changed for that of ordinances.

Some diſtinguiſh three kinds of capitulars, according to the difference of their ſubject-matter; thoſe on eccleſiaſtical affairs are really canons, extracted from councils; thoſe on ſecular affairs, real laws; thoſe relating to particular perſons, or occaſions, private regulations.

CAPITULATION, in *Military* affairs, a treaty made between the inhabitants or garriſon of a place beſieged and the beſiegers, for the delivering up the place on certain conditions. The moſt honourable and ordinary terms of capitulation are, to march out at the breach with arms and baggage, drums beating, colours flying, a match lighted at both ends, and ſome pieces of cannon, waggons and convoys for their baggage, and for their ſick and wounded.

CAPITULATION, in the German polity, a contract which the emperor makes with the electors, in the name of all the princes and ſtates in the empire, before he is declared emperor, and which he ratifies before he is raiſed to that ſovereign dignity. The principal points which the emperor undertakes to obſerve are, 1. To defend the church and empire. 2. To obſerve the fundamental laws of the empire. And, 3. To maintain and preſerve the rights, privileges, and immunities of the electors, princes, and other ſtates of the empire, ſpecified in the capitulation. Theſe articles and capitulations are preſented to the emperor by the electors only, without the concurrence of the other ſtates, who have complained from time to time of ſuch proceedings; and in the time of the Weſtphalian treaty, in 1648, it was propoſed to deliberate in the following diet, upon a way of making a perpetual capitulation: but the electors have always found means of eluding the execution of this article. In order, however, to give ſome ſatisfaction to their adverſaries, they have inſerted in the capitulations of the emperors, and in that of Francis I. in particular, a promiſe to uſe all their influence to bring the affair of a perpetual capitulation to a concluſion. Some German authors own, that this capitulation limits the emperor's power; but maintain that it does not weaken his ſovereignty: though the moſt part maintain that he is not abſolute, becauſe he receives the empire under conditions which ſet bound to abſolute authority.

CAPITULUM, in the ancient military art, was a tranſverſe beam, wherein were holes through which paſſed the ſtrings whereby the arms of huge engines, as baliſtæ, catapultæ, and ſcorpions, were played or worked.

Capitulum, in eccleſiaſtical writers, denoted part of a chapter of the Bible read and explained. In which ſenſe they ſaid, *ire ad capitulum*, "to go to ſuch a lecture." Afterwards the place or apartment where ſuch theological exerciſes were performed was denominated *domus capituli*.

CAPNICON, in *Antiquity*, chimney money, or a tax which the Roman emperors levied for ſmoke, and which of conſequence was due from all, even the pooreſt, who kept a fire. This was firſt invented by Nicephorus.

CAPNOMANCY, a kind of divination by means of ſmoke, uſed by the ancients in their ſacrifices. The words come from *καπνος smoke*, and *μαντεια divination*. The general rule was, when the ſmoke was thin and light, and roſe ſtraight up, it was a good omen; if the contrary, it was an ill one. There was alſo another ſpecies of capnomancy, conſiſting in the obſervation of the ſmoke riſing from poppy and jaſmine ſeed caſt upon lighted coals.

CAPO fino, a large barren rock in the territory of the Genoeſe, which has a caſtle on its eaſtern peak. Near it is a ſmall harbour of the ſame name, 13 miles eaſt by ſouth of Genoa.

Capo *d'Iſtria*, a conſiderable town of Italy, in Iſtria, on the gulf of Trieſte, with a biſhop's ſee, and ſubject to the Venetians. The air is wholeſome and temperate; its principal revenue conſiſts in wine and ſalt. E. Long. 14. 0. N. Lat. 45. 48.

CAPON, a cock chicken, gelded as ſoon as left by the dam, or as ſoon as he begins to crow. They are of uſe either to lead chickens, ducklings, pheaſants, &c. and defend them from the kits and buzzards; or to feed for the table, they being reckoned more delicate than either a cock or a hen.

CAPONIERE, or Capponiere, in fortification, a covered lodgement ſunk four or five feet into the ground encompaſſed with a little parapet about two feet high, ſerving to ſupport ſeveral planks covered with earth. The caponiere is large enough to contain 15 or 20 ſoldiers; and is uſually placed in the glacis on the extremity of the counterſcarp, and in dry moats; having little embraſures for the ſoldiers to fire through.

CAPPADOCIA, an ancient kingdom of Aſia, comprehending all that country which lies between Mount Taurus and the Euxine ſea. It was divided by the Perſians into two ſatrapies or governments; by the Macedonians into two kingdoms, the one called *Cappadocia ad Taurum*; the other *Cappadocia ad Pontum*, and commonly *Pontus*; for the hiſtory, &c. of which laſt, ſee the article Pontus.

Cappadocia *Magna*, or *Cappadocia* properly ſo called, lies between the 38th and 41ſt degrees of north latitude. It was bounded by Pontus on the north, Lycaonia and part of Armenia Major on the ſouth, Galatia on the weſt, and by the Euphrates and part of Armenia Minor on the eaſt. The firſt king of Cappadocia we read of in hiſtory was Pharnaces, who was preferred to the crown by Cyrus king of Perſia, who gave him his ſiſter Atoſſa in marriage. This is all we find recorded of him, except that he was killed in a war with the Hyrcanians. After him came a ſucceſſion of eight kings, of whom we know ſcarce any thing but that they continued faithful to the Perſian intereſt. In the time of Alexander the Great, Cappadocia was governed by Ariarathes II., who, notwithſtanding the vaſt conqueſts and fame of the Macedonian monarchy, continued unſhaken in his fidelity to the Perſians. Alexander was prevented by death from invading his dominions; but Perdiccas, marching againſt him with a powerful and well diſciplined army, diſperſed his forces, and having taken Ariarathes himſelf priſoner, crucified him with all thoſe of the royal blood whom he could get into his power. Diodorus tells us that he was killed in the battle. He is ſaid to have reigned 82 years. His ſon Ariarathes III. having eſcaped the general ſlaughter of the royal family, fled into Armenia, where he lay concealed till the civil diſſenſions which roſe among the Macedonians gave him a fair opportunity of recovering his paternal kingdom. Amyntas, at that time the governor of Cappadocia, oppoſed him: but being defeated in a pitched battle, the Macedonians were obliged to abandon all the ſtrong holds. Ariarathes, after a long and peaceable reign, left his kingdom to his ſon Ariaramnes II. He applied himſelf more to the arts of peace than war, in conſequence of which Cappadodia flouriſhed greatly during his reign. He was ſucceeded by his ſon Ariarathes IV. who proved a very warlike prince, and, having overcome Arſaces, founder of the Parthian monarchy, conſiderably enlarged his own dominions.

He was ſucceeded by Ariarathes V. who, marrying the daughter of Antiochus the great, entered into an alliance with that prince againſt the Romans; but Antiochus being defeated, the king of Cappadocia was obliged to ſue for peace, which he obtained, after having paid 200 talents by way of fine, for taking up arms againſt the people of Rome. He afterwards aſſiſted the republic with men and money againſt Perſeus king of Macedon, on which account he was by the ſenate honoured with the title of *the friend and ally of the Roman people*. He left the kingdom in a very flouriſhing condition to his ſon Mithridates, who on his acceſſion took the name of Ariarathes VI.

This prince, (ſurnamed *Philopater*, from the filial reſpect and love he ſhowed his father from his very infancy) immediately renewed the alliance with Rome. Out of mere good nature, he reſtored Mithrobuzanes, Cappadocia.

ſon to Ladriades, king of the Leſſer Armenia, to his father's kingdom, though he foreſaw that the Armenians would lay hold of that opportunity to join Artaxias, who was then on the point of invading Cappadocia. Theſe differences, however, were ſettled before they came to an open rupture by the Roman legates; and Ariarathes ſeeing himſelf thus delivered from an impending war by the mediation of the republic, preſented the ſenate with a golden crown; and offered his ſervice whatever they thought proper to employ him. The ſenate in return ſent him a ſtaff, and chair of ivory; which were preſents uſually beſtowed on thoſe only whom they looked upon as attached to their intereſt. Not long before this, Demetrius Soter king of Syria had offered Ariarathes his ſiſter in marriage, the widow of Perſeus king of Macedon: but this offer the king of Cappadocia was obliged to decline for fear of offending the Romans; and his ſo doing was in the higheſt degree acceptable to the republic, who reckoned him among the chief of her allies. Demetrius, however, being greatly incenſed at the ſlight put upon his ſiſter, ſet up a pretender to the throne, one Orophernes, a ſuppoſititious, or, as others call him, a natural ſon of the deceaſed king. The Romans ordered Eumenes king of Pergamus to aſſiſt Ariarathes with all his forces: which he did, but to no purpoſe; for the confederates were overthrown by Demetrius, and Ariarathes was obliged to abandon the kingdom to his rival. This happened about 159 years before Chriſt, and the uſurper immediately diſpatched ambaſſadors to Rome with a golden crown. The ſenate declined accepting the preſent, till they heard his pretenſions to the kingdom; and this Orophernes, by ſuborned witneſſes, made appear ſo plain, that the ſenate decreed that Ariarathes and he ſhould reign as partners; but next year Orophernes was driven out by Attalus brother to Eumenes, and his ſucceſſor to the kingdom of Pergamus.

Ariarathes, being thus reſtored, immediately demanded of the Priennians 400 talents of gold which Orophernes had depoſited with them. They honeſtly replied, that as they had been truſted with the money by Orophernes, they could deliver it to none but himſelf, or ſuch as came in his name. Upon this, the king entered their territories with an army, deſtroying all with fire and ſword. The Priennians, however, ſtill perſevered in their integrity; and though their city was beſieged by the united forces of Ariarathes and Attalus, not only made an obſtinate defence, but found means to reſtore the ſum to Orophernes. At laſt they applied to the Romans for aſſiſtance, who enjoined the two kings to raiſe the ſiege, under pain of being declared enemies to the republic. Ariarathes immediately obeyed; and marching his army into Aſſyria, joined Alexander Epiphanes againſt Demetrius Soter, by whom he had been formerly driven out of his kingdom. In the very firſt engagement Demetrius was ſlain, and his army entirely diſperſed, Ariarathes having on that occaſion given uncommon proofs of his courage and conduct. Some years after, a war breaking out between the Romans and Ariſtonicus who claimed the kingdom of Pergamus in right of his father, Ariarathes joined the former, and was ſlain in the ſame battle in which P. Craſſus proconſul of Aſia was taken, and the Roman army cut in pieces. He left ſix ſons by his wife Laodice, on whom the Romans beſtowed Lycaonia and Cilicia. But Laodice, fearing leſt her children, when they came to age, ſhould take the government out of her hands, poiſoned five of them, the youngeſt only having eſcaped her cruelty by being conveyed out of the kingdom. The queen herſelf was ſoon after put to death by her ſubjects, who could not bear her cruel and tyrannical government.

Laodice was ſucceeded by Ariarathes VII. who, ſoon after his acceſſion, married another Laodice, daughter to Mithridates the Great, hoping to find in that prince a powerful friend to ſupport him againſt Nicomedes king of Bithynia who laid claim to part of Cappadocia. But Mithridates, inſtead of aſſiſting, procured one Gordius to poiſon his unhappy ſon-in-law, and on his death, ſeized the kingdom, under pretence of maintaining the rights of the Cappadocians againſt Nicomedes, till the children of Ariarathes were in a condition to govern the kingdom. The Cappadocians at firſt fancied themſelves obliged to their new protector: but, finding him unwilling to reſign the kingdom to the lawful heir, they roſe up in arms, and driving out all the garriſons placed by Mithridates, placed on the throne Ariarathes VIII. eldeſt ſon of their deceaſed king.

The new prince found himſelf immediately engaged in a war with Nicomedes; but, being aſſiſted by Mithridates, not only drove him out of Cappadocia, but ſtripped him of a great part of his hereditary dominions. On the concluſion of the peace, Mithridates, ſeeking for ſome pretence to quarrel with Ariarathes, inſiſted upon his recalling Gordius, who had murdered his father; which being rejected with abhorrence, a war enſued. Mithridates took the field firſt, in hopes of overrunning Cappadocia before Ariarathes could be in a condition to make head againſt him; but, contrary to his expectation, he was met on the frontiers by the king of Cappadocia with an army no way inferior to his own. Hereupon he invited Ariarathes to a conference; and, in ſight of both armies, ſtabbed him with a dagger, which he had concealed under his garment. This ſtruck ſuch terror into the Cappadocians, that they immediately diſperſed, and gave Mithridates an opportunity of poſſeſſing himſelf of the kingdom without the leaſt oppoſition. The Cappadocians, however, not able to endure the tyranny of his prefects, ſoon ſhook off the yoke; and recalling the king's brother, who had fled into the province of Aſia, proclaimed him king. He was ſcarce ſeated on the throne, however, before Mithridates invaded the kingdom at the head of a very numerous army, and having drawn Ariarathes to a battle, defeated his army with great ſlaughter, and obliged him to abandon the kingdom. The unhappy prince ſoon after died of grief; and Mithridates beſtowed the kingdom on his ſon, who was then but eight years old, giving him alſo the name of *Ariarathes*. But Nicomedes Philopater king of Bithynia, fearing leſt Mithridates, having now got poſſeſſion of the whole kingdom of Cappadocia, ſhould invade his territories, ſuborned a youth to paſs himſelf for the third ſon of Ariarathes, and to preſent to them a petition in order to be reſtored to his father's kingdom. With him he ſent to Rome Laodice, ſiſter of Mithridates, whom he had married after the death of her former huſband Ariarathes. Loadice declared before the

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ſenate, that ſhe had three ſons by Ariarathes, and that the petitioner was one of them; but that ſhe had been obliged to keep him concealed, leſt he ſhould undergo the ſame fate with his brothers. The ſenate aſſured him that they would at all events reinſtate him in his kingdom. But, in the mean time, Mithridates, having notice of theſe tranſactions, diſpatched Gordius to Rome, to undeceive the ſenate, and to perſuade them that the youth to whom he had reſigned the kingdom of Cappadocia was the lawful ſon of the late king, and grandſon to Ariarathes who had loſt his life in the ſervice of the Romans againſt Ariſtonicus. This unexpected embaſſy put the ſenate upon enquiring more narrowly into the matter, whereby the whole plot was diſcovered; upon which Mithridates was ordered to reſign Cappadocia, and the kingdom was declared free. The Cappadocians, however, in a ſhort time ſent ambaſſadors to Rome, acquainting the ſenate that they could not live without a king. This greatly ſurpriſed the Romans, who had ſuch an averſion to royal authority; but they gave them leave to elect a king of their own nation. As the family of Pharnaces was now extinct, the Cappadocians choſe Ariobarzanes; and their choice was approved by the ſenate, he having on all occaſions ſhown himſelf a ſteady friend to the Romans.

Ariobarzanes had ſcarce taken poſſeſſion of his kingdom when he was driven out by Tigranes king of Armenia: who reſigned Cappadocia to the ſon of Mithridates, in purſuance of an alliance previouſly concluded between the two parties. Ariobarzanes fled to Rome; and, having engaged the ſenate in his cauſe, he returned into Aſia with Sylla, who was enjoined to reſtore him to his kingdom. This was eaſily performed by Sylla, who, with a ſmall body of troops, routed Gordius who came to meet him on the borders of Cappadocia at the head of a numerous army. Sylla, however, had ſcarce turned his back, when Ariobarzanes was again driven out by Ariarathes the ſon of Mithridates, on whom Tigranes had beſtowed the kingdom of Cappadodia. This obliged Sylla to return into Aſia, where he was attended with his uſual ſucceſs, and Ariobarzanes was again placed on the throne. After the death of Sylla, he was the third time forced by Mithridates to abandon his kingdom; but Pompey, having entirely defeated Mithridates near Mount Stella, reſtored Ariobarzanes to his throne, and rewarded him for his ſervices during the war, with the provinces of Sophene, Gordiene, and great part of Cilicia. The king, however, being now advanced in years, and deſirous of ſpending the remainder of his life in eaſe, reſigned the crown to his ſon Ariobarzanes, in preſence of Pompey; and never afterwards troubled himſelf with affairs of ſtate.

Ariobarzanes II. proved no leſs faithful to the Romans than his father had been. On the breaking out of the civil war between Cæſar and Pompey, he ſided with the latter; but, after the death of Pompey, he was received into favour by Cæſar, who even beſtowed upon him great part of Armenia. While Cæſar was engaged in a war with the Egyptians, Pharnaces king of Pontus invaded Cappadocia, and ſtripped Ariobarzanes of all his dominions; but Cæſar, having defeated Pharnaces, reſtored the king of Cappadocia, and honoured him with new titles of friendſhip. After the murder of Cæſar, Ariobarzanes, having refuſed to join Brutus and Caſſius, was by them declared an enemy to the republic, and ſoon after taken priſoner and put to death. He was ſucceeded by his brother Ariobarzanes III. who was by Mark Antony deprived both of his kingdom and his life: and in him ended the family of Ariobarzanes.

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Archelaus, the grandſon of that general of the ſame name who commanded againſt Sylla in the Mithridatic war, was by Mark Antony placed on the throne of Cappadocia, though nowiſe related either to the family of Pharnaces or Ariobarzanes. His preferment was entirely owing to his mother Glaphyra, a woman of great beauty, but of looſe behaviour, who, in return for her compliance with the deſires of Antony, obtained the kingdom of Cappadocia for her ſon. In the war between Auguſtus and Antony, he joined the latter; but, at the interceſſion of the Cappadocians, was pardoned by the emperor. He afterwards received from him Armenia the leſſer, and Cilicia Trachæa, for having aſſiſted the Romans in clearing the ſeas of pirates, who greatly infeſted the coaſts of Aſia. He contracted a ſtrict friendſhip with Herod the Great, king of Judea; and even married his daughter Glaphyra to Alexander, Herod's ſon. In the reign of Tiberius, Archelaus was ſummoned to appear before the ſenate; for he had always been hated by that emperor, becauſe in his retirement at Rhodes he had paid him no ſort of reſpect. This had proceeded from no averſion in him to Tiberius, but from the warning given by Archelaus to his friends at Rome. For Caius Cæſar, the preſumptive heir to the empire, was then alive, and had been ſent to compoſe the differences of the eaſt: whence the friendſhip of Tiberius was then looked upon as dangerous. But when he came to the empire, Tiberius, remembering the diſreſpect ſhown him by Archelaus, enticed the latter to Rome by means of letters from Livia, who promiſed him her ſon Tiberius's pardon, provided he came in perſon to implore it. Archelaus obeyed the ſummons, and haſtened to Rome; where he was received by the emperor with great wrath and contempt, and ſoon after accuſed as a criminal in the ſenate. The crimes of which he was accuſed were mere fictions; but his concern at ſeeing himſelf treated as a malefactor was ſo great, that he died ſoon after of grief, or, as others ſay, laid violent hands on himſelf. He is ſaid to have reigned 50 years.

On the death of Archelaus, the kingdom of Cappadocia was reduced to a Roman province, and governed by thoſe of the equeſtrian order. It continued ſubject to the Romans till the invaſion of the eaſtern empire by the Turks, to whom it is now ſubject, but has no diſtinguiſhing modern name. In what was anciently called *Cappadocia*, however, the Turks have four beglerbeglics, called *Siwas*, *Trebizond*, *Maraſch*, and *Cogni*.

In the time of the Romans, the inhabitants of Cappadocia bore ſo bad a character, and were reputed ſo vicious and lewd, that, among the neighbouring nations, a wicked man was emphatically called a *Cappadocian*. In after ages, however, their lewd diſpoſition was ſo corrected and reſtrained by the pure doctrines of Chriſtianity, that no country whatever has produced greater champions of the Chriſtian religion, or given to the church prelates of more unblemiſhed characters.

We have now no ſyſtem of the Cappadocian laws, and ſcarce wherewithal to form any particular idea of them. As to their commerce, they carried on a conſiderable trade in horſes, great numbers of which were produced in their country; and we read of them in Scripture as frequenting the fairs of Tyre with this commodity. As Cappadocia abounded with mines of ſilver, braſs, iron, and alum, and afforded great ſtore of alabaſter, cryſtal, and jaſper, it is probable that they might ſupply the neighbouring countries with theſe commodities.

The religion of the ancient Cappadocians was much the ſame with that of the Perſians. At Comana there was a rich and ſtately temple dedicated to Bellona; whoſe battles the prieſts and their attendants uſed to repreſent on ſtated days, cutting and wounding each other as if ſeized with an enthuſiaſtic fury. No leſs famous and magnificent were the temples of Apollo Catanius, and of Jupiter: the laſt of which had 3000 ſacred ſervants, or religious votaries. The chief prieſt was next in rank to that of Comana; and, according to Strabo, had a yearly revenue of 15 talents. Diana Perſica was worſhipped in a city called *Caſtaballa*, where women, devoted to the worſhip of that goddeſs, were reported to tread barefooted on burning coals, without receiving any hurt. The temples of Diana at Dioſpolis, and of Anias at Zela, were likewiſe held in great veneration both by the Cappadocians and Armenians, who flocked to them from all parts. In the latter were tendered all oaths in matters of conſequence; and the chief among the prieſts was no way inferior in dignity, power, and wealth, to any in the kingdom; having a royal attendance, and an unlimited authority over all the inferior ſervants and officers of the temple. The Romans, who willingly adopted all the ſuperſtitions and ſuperſtitious rites of the nations they conquered, greatly increaſed the revenues of this and other temples; conferring the prieſthood on ſuch as they thought moſt fit for carrying on their deſigns.---We are told that human ſacrifices were offered at Comana; and that this barbarous cuſtom was brought by Oreſtes and his ſiſter Iphigenia from Taurica Scythica, where men and women were immolated to Diana. But this cuſtom, if ever it obtained in Cappadocia, was aboliſhed in the times of the Romans.

CAPPANUS, a name given by ſome authors to a worm that adheres to and gnaws the bottoms of ſhips; to which it is extremely pernicious, eſpecially in the Eaſt and Weſt Indies; to prevent this, ſeveral ſhips have lately been ſheathed with copper; the firſt trial of which was made on his majeſty's frigate the Alarm.

CAPPARIS. See Botany *Index*.

The buds of this plant pickled with vinegar, &c. are brought to Britain annually from Italy and the Mediterranean. They are ſuppoſed to excite appetite and aſſiſt digeſtion; and to be particularly uſeful as detergents and aperients in obſtructions of the liver and ſpleen.

CAPRA, or Goat. See Mammalia *Index*.

Capra *Saltans*, in *Meteorology*, a fiery meteor or exhalation ſometimes ſeen in the atmoſphere. It forms an inflected line, reſembling in ſome meaſure the caperings of a goat; whence it has its name.

CAPRALA, an iſle of Italy, in the Tuſcan ſea, to the north-eaſt of Corſica, on which it depends. It is pretty populous, and has a ſtrong caſtle for it defence. It is about 15 miles in circumference. E. Long. 11. 5. N. Lat. 43. 15.

CAPRARIA. See Botany *Index*.

CAPRAROLA, one of the moſt magnificent palaces in Italy, ſeated on a hill, in Ronciglione, whoſe foot is watered by the river Tircia. It was built by Cardinal Farneſe; and has five fronts, in the middle of which is a round court, though all the rooms are ſquare, and well proportioned. Is is 27 miles north-weſt of Rome.

CAPRÆ. See Capri.

CAPREOLUS, Elias, an excellent civilian, and learned hiſtorian, born at Breſcia in Italy, wrote a hiſtory of Breſcia, and other works: died in 1519.

CAPRI, (ancienty *Capreæ*), a city and iſland at the entrance of the gulf of Naples, E. Long. 14. 50. N. Lat. 40. 45.---The iſland is only four miles long and one broad; the city is a biſhop's ſee, and ſituated on a high rock at the weſt end of the iſland. Capreæ was anciently famous for the retreat of the emperor Tiberius for ſeven years, during which he indulged himſelf in the moſt ſcandalous debaucheries*. Before Tiberius came hither, Capri had attracted the notice of Auguſtus, as a moſt eligible retreat, though in ſight of populous cities, and almoſt in the centre of the empire. His ſucceſſor preferred it to every other reſidence; and in order to vary his pleaſures, and enjoy the advantages as well as avoid the inconveniences of each revolving ſeaſon, built 12 villas in different ſituations, dedicated to the 12 greater gods: the ruins of ſome of them are ſtill to be ſeen: at Santa Maria are extenſive vaults and reſervoirs; and on an adjoining brow are the remains of a lighthouſe; two broken columns indicate the entrance of the principal court. According to Dion Caſſius, this iſland was wild and barren before the Cæſars took it under their immediate protection: at this day a large portion of its ſurface is uncultivated and impracticable; but every ſpot that will admit the hoe is induſtriouſly tilled, and richly laden with the choiceſt productions of agriculture. The odium attached to the memory of Tiberius proved fatal to his favourite abode; ſcarce was his death proclaimed at Rome, when the ſenate iſſued orders for the demolition of every fabric he had raiſed on the iſland, which by way of puniſhment was thenceforward deſtined to be a ſtate priſon. The wife and ſiſter of Commodus were baniſhed to its inhoſpitable rocks, which were ſoon ſtained with their blood. In the middle ages Capri became an appendage of the Amalfitan republic, and after the downfal of that ſtate, belonged to the duchy of Naples. There ſtood a pharos on this iſland, which, a few days before the death of Tiberius, was overthrown by an earthquake.

* See *Tiberius*.

CAPRIATA, Peter John, a civilian and hiſtorian, was born at Genoa. He wrote, in Italian, the hiſtory of the wars of Italy; an Enliſh tranſlation of which was printed in London in 1663.

CAPRICORN, in *Aſtronomy*, one of the 12 ſigns of the zodiac. See Astronomy *Index*.

The ancients accounted Capricorn the tenth ſign; and when the ſun arrived thereat, it made the winter ſolſtice with regard to our hemiſphere: but the ſtars having advanced a whole ſign towards the eaſt, Capricorn is now rather the 11th ſign; and it is at the ſun's entry into Sagittary that the ſolſtice happens, though the ancient manner of ſpeaking is ſtill retained.

This ſign is repreſented on ancient monuments, medals, &c. as having the forepart of a goat and the hindpart of a fiſh, which is the form of an Ægipan; ſometimes ſimply under the form of a goat.

Tropic of CAPRICORN, a leſſer circle of the ſphere, which is parallel to the equinoctial, and at 23° 30′ diſtance from it ſouthwards; paſſing through the beginning of Capricorn.

CAPRIFICATION, a method uſed in the Levant, for ripening the fruit of the domeſtic fig tree, by means of inſects bred in that of the wild fig tree.

The moſt ample and ſatisfactory accounts of this curious operation in gardening, are thoſe of Tourneſort and Pontedra: the former, in his Voyage to the Levant, and in a Memoir delivered to the Academy of Sciences at Paris in 1705; the latter, in his *Anthologia*. The ſubſtance of Tourneſort's account follows: "Of the thirty ſpecies or varieties of the domeſtic fig tree which are cultivated in France, Spain, and Italy, there are but two cultivated in the Archiepelago. The firſt ſpecies is called *ornos*, from the old Greek *erinos*, which anſwers to *caprificus* in Latin, and ſignifies a wild fig-tree. The ſecond is the domeſtic or garden fig-tree. The former bears ſucceſſively, in the ſame year, three ſorts of fruit, called *fornites*, *cratitires*, and *orni*; which, though not good to eat, are found abſolutely neceſſary towards ripening thoſe of the garden fig. Theſe fruits have a ſleek even ſkin; are of a deep green colour; and contain in their dry and mealy inſide ſeveral male and female flowers placed upon diſtinct footſtalks, the former above the latter. The *fornites* appear in Auguſt, and continue to November without ripening: in theſe are bred ſmall worms, which turn to a ſort of gnats, nowhere to be ſeen but about theſe trees. In October and November, theſe gnats of themſelves make a puncture into the ſecond fruit, which is called *cratitires*. Theſe do not ſhow themſelves till towards the end of September. The *fornites* gradually fall away after the gnats are gone; the *cratitires*, on the contrary, remain on the tree till May, and encloſe the eggs depoſited by the gnats when they pricked them. In May, the third ſort of fruit, called *orni*, begins to be produced by the wild fig-trees. This is much bigger than the other two; and when it grows to a certain ſize, and its bud begins to open, it is pricked in that part by the gnats of the *cratitires*, which are ſtrong enough to go from one fruit to another to depoſite their eggs. It ſometimes happens that the gnats of the *cratitires* are ſlow to come forth in certain parts, while the *orni* in thoſe very parts are diſpoſed to receive them. In this caſe, the huſbandman is obliged to look for the *cratitires* in another part, and fix them at the ends of the branches of thoſe fig trees whoſe *orni* are in a fit diſpoſition to be pricked by the gnats. If they miſs the opportunity, the *orni* fall, and the gnats of the *cratitires* fly away. None but thoſe that are well acquainted with the culture know the critical moment of doing this; and in order to know it, their eye is perpetually fixed on the bud of the fig; for that part not only indicates the time that the prickers are to iſſue forth, but alſo when the fig is to be ſucceſsfully pricked: if the bud is too hard and compact, the gnat cannot lay its eggs; and the fig drops when the bud is too open.

"The uſe of all theſe three ſorts of fruit is to ripen the fruit of the garden fig-tree, in the following manner: During the months of June and July, the peaſants take the *orni*, at the time their gnats are ready to break out, and carry them to the garden fig-trees: if they do not nick the moment, the *orni* fall; and the fruit of the domeſtic fig-tree, not ripening, will in a very little time fall in like manner. The peaſants are ſo well acquainted with theſe precious moments, that, every morning, in making their inſpection, they only transfer to their garden fig-trees ſuch *orni* as are well conditioned, otherwiſe they loſe their crop. In this caſe, however, they have one remedy, though an indifferent one; which is, to ſtrew over the garden fig-trees another plant in whoſe fruit there is alſo a ſpecies of gnats which anſwer the purpoſe in ſome meaſure."

The caprification of the ancient Greeks and Romans, deſcribed by Theophraſtus, Plutarch, Pliny, and other authors of antiquity, correſponds in every circumſtance with what is practiſed at this day in the Archiepelago and in Italy. Theſe all agree in declaring, that the wild fig-tree, *caprificus*, never ripened its fruit; but was abſolutely neceſſary for ripening that of the garden or domeſtic fig, over which the huſbandmen ſuſpended its branches. The reaſon of this ſucceſs has been ſuppoſed to be, that by the punctures of theſe inſects the veſſels of the fruit are lacerated, and thereby a greater quantity of nutritious juice derived thither. Perhaps, too, in depoſiting their eggs, the gnats leave behind them ſome ſort of liquor proper to ferment gently with the milk of the figs, and to make their fleſh tender. The figs in Provence, and even at Paris, ripen much ſooner for having their buds pricked with a ſtraw dipped in olive-oil. Plums and pears likewiſe, pricked by ſome inſects, ripen much the faſter for it; and the fleſh round ſuch puncture is better taſted than the reſt. It is not to be diſputed, that conſiderable changes happen to the contexture of fruits ſo pricked, juſt the ſame as to parts of animals pierced with any ſharp inſtrument. Others have ſuppoſed that theſe inſects penetrated the fruit of the tree to which the were brought, and gave a more free admiſſion to the air, and to the ſun. Linnæus explained the operation, by ſuppoſing that the inſects brought the farina from the wild fig, which contained male flowers only, to the domeſtic fig, which contained the female ones. Haſſelquiſt, from what he ſaw in Paleſtine, ſeemed to doubt of this mode of fructification. M. Bernard, in the Memoirs of the Society of Agriculture, oppoſes it more decidedly. He could never find the inſect in the cultivated fig; and, in reality, it appeared to leave the wild fig, after the ſtamina were mature, and their pollen diſſipated: beſides, he adds, what they may have brought on their wings muſt be rubbed away, in the little aperture which they would form for themſelves. At Malta, where there are ſeven or eight varieties of the domeſtic fig, this operation is only performed on thoſe which ripen lateſt: the former are of a proper ſize, fine flavour, and in great abundance without it; ſo that he thinks the caprification only haſtens the ripening. He examined the parts of fructification of the fig; and he obſerves, if this examination be made previous to the ripening, that round the eye of the fig, and in the ſubſtance of its covering, may be ſeen triangular dentated leaves, preſſed one againſt another; and under theſe leaves are the ſtamina, whoſe pollen is deſtined for the impregnation of the grains, which fill the reſt of the fruit. Theſe male organs are much more numerous in the wild-fig than in the domeſtic; and the ſtamina are found to contain a yellow duſt, which may be collected when it is ripe. The wild figs, when ripe, are not ſucculent, and have no taſte, though the grains are diſpoſed in the ſame manner as in the other kind. The pith of the grain of the wild fruit ſerves as food to a ſpecies of the cynips, whoſe larva is white, till the moment of its transformation; and it is by an opening, in the direction of the piſtil, that the inſect penetrates the grain. From this account it is thought probable that the inſect is only communicated by accident to the domeſtic fig, and that the flowers of this genus are ſometimes hermaphrodites. But the number of hermaphrodite flowers being fewer on the cultivated than on the wild fig, the ſeeds are fecundated more certainly and quickly by the caprification; and every botaniſt knows, that when the impregnation is completed, the flower ſoon withers; while, if by any accident it is delayed, it continues in bloom much longer. This view of the ſubject, therefore, explains very completely the reaſon why, in Malta, the caprification is practiſed on the late kind of figs, becauſe it haſtens the formation and maturity of the fruit.

CAPRIMULGUS, Goatsucker, or *Fern-owl*. See Ornithology *Index*.

CAPRIOLES, in the *Manege*, leaps that a horſe makes in the ſame place without advancing, in ſuch a manner, that, when he is at the height of the leap, he jerks out with his hinder legs even and near. It is the moſt difficult of all the high manege. It differs from a croupade, in this, that, in a croupade, a horſe does not ſhow his ſhoes; and from a ballotade, becauſe in this he does not jerk out. To make a horſe work well at caprioles, he muſt be put between two pillars, and taught to raiſe firſt his fore quarters, and then his hind quarters while his fore ones are yet in the air; for which reaſon you muſt give him the whip and the poinſon.

CAPSA, in *Ancient Geography*, a large and ſtrong town of Numidia, ſituated amidſt vaſt deſerts, waſte, uncultivated, and full of ſerpents, where Jugurtha kept his treaſure. In his time it was taken and razed by Marius the Roman general, who put to death all the citizens capable of bearing arms, and ſold the reſt for ſlaves. It was, however, afterwards rebuilt by the Romans, and ſtrongly fortified; but, on the decline of their empire, was taken and demoliſhed a ſecond time, by Occuba a famous Arab general. The walls of the citadel are ſtill remaining, and are monuments of the ancient glory and ſtrength of Capſa. They are 24 fathoms in height, and five in thickneſs, built of large ſquare ſtones, and have now acquired the ſolidity and firmeſs of a rock. The walls of the town were rebuilt by the inhabitants ſince their firſt demolition; but were afterwards deſtroyed by Jacob Almanzar, who ſent a governor and troops into the province. In Marmol's time Capſa was very populous, and abounded with ſtately moſques and other ſtructures of ſuperb and elegant workmanſhip: but at preſent it is occupied by a poor and indigent people, fleeced and oppreſſed by the Tuneſe government. In the very centre of the city ſtands an encloſed fountain, which both ſupplies the people with drink, and affords them an agreeable bath. The adjacent country is now cultivated, and produces ſeveral kinds of fruits; but the climate is unhealthy. The inhabitants are remarkable for their peeviſhneſs of temper. Both men and women dreſs handſomely except their feet, which they cover with courſe ſhoes of bungling workmanſhip, and made of the rough ſkins of wild beaſts, equally inconvenient and unbecoming. E. Long. 9. 3. N. Lat. 33. 15.

CAPSARIUS, (from *capsa*, ſatchel), in antiquity, a ſervant who attended the Roman youth to ſchool, carrying a ſatchel with their books in it, ſometimes alſo called librarius.

Capsarius was alſo an attendant at the baths, to whom perſons committed the keeping of their clothes.

Capsarius (from *capsa*, "a cheſt,"), among the Roman bankers, was he who had the care of the money cheſt or coffer.

CAPISCUM, or Guinea-pepper. See Botany *Index*.

The bell-pepper produces fruit fit for pickling; for which purpoſe they muſt be gathered before they arrive at their full size, while their rind is tender. They muſt be ſlit down on one ſide to get out the ſeeds, after which they ſhould be ſoaked two or three days in ſalt and water; when they are taken out of this and drained, boiling vinegar muſt be poured on them in a ſufficient quantity to cover them, and cloſely ſtopped down for two months; then they ſhould be boiled in the vinegar to make them green; but they want no addition of any ſpice, and are the wholeſomeſt and beſt pickle in the world. Another ſpecies is uſed for making what is called *cayan-butter* or *pepper-pots*, by the inhabitants of America, and which they eſteem the beſt of all the ſpices. The following is a receipt for making of a pepper-pot: "Take of the ripe ſeeds of this ſort of capſicum, and dry them well in the ſun; then put them into an earthen or ſtone pot, mixing flour between every ſtratum of pods; and put them into an oven after the baking of bread, that they may be thoroughly dried: after which they muſt be well cleanſed from the flour; and if any of the ſtalks remain adhering to the pods, they ſhould be taken off, and the pods reduced to a fine powder; to every ounce of this add a pound of white flour, and as much leaven as is ſufficient for the quantity intended. After this has been properly mixed and wrought, it ſhould be made into ſmall cakes, and baked in the ſame manner as common cakes of the ſame ſize: then cut them into ſmall parts, and bake them again, that they may be as dry and hard as biſcuit; which being powdered and ſifted, is to be kept for uſe." This is prodigiouſly hot and acrimonious, ſetting the mouth as it were on fire. It is by ſome recommended as a medicine for flatulencies; but it is greatly to be doubted whether all thoſe hot irritating medicines are not productive of more harm than good, in this country at leaſt. If the ripe pods of capſicum are thrown into the fire, they will raiſe ſtrong and noiſome vapours, which occaſion vehement ſneezing, coughing, and often vomiting, in thoſe who are near the place, or in the room where they are burnt. Some perſons have mixed the powder of the pods with ſnuff, to give to others for diverſion: but where it is in quantity, there may be danger in uſing it; for it will occaſion ſuch violent fits of ſneezing, as may break the blood veſſels of the head.

CAPSQUARES, ſtrong plates of iron which come over the trunnions of a gun, and keep it in the carriage. They are faſtened by a hinge to the prize-plate, that they may lift up and down, and form a part of an arch in the middle to receive a third part of the thickneſs of the trunnions: for two-thirds are let into the carriage, and the other end is faſtened by two iron wedges called the *fore-locks* and *keys*.

CAPSTAN, or CAPSTERN, a ſtrong maſſy column of timber, formed like a truncated cone, and having its upper extremity pierced with a number of holes to receive the bars or levers. It is let perpendicularly down through the decks of a ſhip; and is fixed in ſuch a manner, that the men, by turning it horizontally with their bars, may perform any work which requires an extraordinary effort.

Plate CXXXV.

A capſtern is compoſed of ſeveral parts, where A is the barrel, *b* the whelps, *c* the drumhead, and *d* the ſpindle. The whelps riſe out from the main body of the capſtern like buttreſſes, to enlarge the ſweep, ſo that a greater quantity of cable, or whatever rope encircles the barrel, may be wound about it at one turn, without adding much to the weight of the capſtern. The whelps reach downwards from the lower part of the drumhead to the deck. The drumhead is a broad cylindrical piece of wood reſembling a mill-ſtone, and fixed immediately above the barrel and whelps. On the outſide of this piece are cut a number of ſquare holes parallel to the deck to receive the bars. The ſpindle or pivot *d*, which is ſhod with iron, is the axis or foot upon which the capſtern reſts, and turns round in the ſaucer, which is a ſort of iron ſocket let into a wooden ſtock or ſtandard called the *ſtep*, reſting upon and bolted to the beams.

Beſides the different parts of the capſtern above explained, it is furniſhed with ſeveral appurtenances, as the *bars*, the *pins*, the *pawls*, the *ſwifter*, and the *ſaucer*, already deſcribed. The bars are long pieces of wood, or arms, thruſt into a number of ſquare holes in the drumhead all round, in which they are as the radii of a circle, or the ſpokes in the nave of a wheel. They are uſed to heave the capſtern round, which is done by the men ſetting their breaſts againſt them, and walking about, like the machinery of a horſe mill, till the operation is finiſhed.—The pins *e*, are little bolts of iron thurſt perpendicularly through the holes of the drumhead, and through a correſpondent hole in the end of the bar, made to receive the pins when the bars are fixed. They are uſed to confine the bars, and to prevent them from working out as the men heave, or when the ſhip labours. Every pin is faſtened to the drumhead with a ſmall iron chain; and that the bars may exactly fit their reſpective holes, they are all numbered.—The pawls *f*, N° 1. are ſituated on each ſide the capſtern, being two ſhort bars of iron, bolted at one end through the deck to the beams cloſe to the lower part of the whelps; the other end, which occaſionally turns round on the deck, being placed in the intervals of the whelps, as the capſtern turns round, prevents it from recoiling or turning back by any ſudden jerk of the cable, as the ſhip riſes on the ſea, which might greatly endanger the men who heave. There are alſo hanging pawls *gg*, N° 3. uſed for the ſame purpoſes, reaching from the deck above to the drumhead immediately below it. The ſwifter is a rope paſſed horizontally through holes in the outer end of the bars, and drawn very tight; the intent of this is to keep the men ſteady as they walk round when the ſhip rocks, and to give room for a greater number to aſſiſt by pulling upon the ſwifter itſelf.

The moſt frequent uſe of the capſtern is to heave in the cable, and thereby remove the ſhip or draw up the anchor. It is alſo uſed to wind up any weighty body, as the maſts, artillery, &c. In merchant ſhips it is likewiſe frequently employed to diſcharge or take in the cargo, particularly when conſiſting of weighty materials that require a great exertion of mechanical powers to be removed.

There are commonly two capſterns in a man of war, the *main* and the *gear* capſtern; the former of which has two drumheads, and may be called a *double one*. This is repreſented in N° 3. The letter is repreſented in N° 2.

Formerly the bars of the capſtern went entirely through the head of it, and conſequently were more than double the length of the preſent ones; the holes were therefore formed at different heights, as repreſented in N° 1. But this machine had ſeveral inconveniences, and has long been entirely diſuſed in the navy. Some of theſe ſort of capſterns, however, are ſtill retained in merchant ſhips, and are uſually denominated *crabs*. The ſituation of the bars in a crab, as ready for heaving, is repreſented in N° 4.

To rig the CAPSTERN, is to fix the bars in their reſpective holes, and thruſt in the pins, in order to confine them.—*Surge the* CAPSTERN, is the order to ſlacken the rope heaved round upon it, of which there are generally two turns and a half about the barrel at once, and ſometimes three turns.—*To Heave the* CAPSTERN, is to go round with it heaving on the bars, and drawing in any rope of which the purchaſe is created.—*To come-up the* CAPSTERN, is to let go the rope upon which they had been heaving.—*To Pawl the* CAPSTERN, is to fix the pawls to prevent it from recoiling during any pauſe of heaving.

CAPSULE, in a general ſenſe, denotes a receptacle or cover in form of a bag,

CAPSULE, among botaniſts, a dry hollow ſeed-veſſel or pericarpium, that cleaves or ſplits in ſome determinate manner. See PERICARPIUM, BOTANY *Index*.

This ſpecies of ſeed-veſſel is frequently fleſhy and ſucculent, like a berry, before it has attained maturity; but, in ripening, becomes dry, and often ſo elaſtic as to dart the ſeeds from their departments with conſiderable velocity. This elaſticity is remarkably conſpicuous in wood ſorrel; balſam *impatiens*; African ſpiræa, *dioſma*: *fraxinella*; *juſticia*; *ruellia*: *barleria*; *lathræa*; and many others.—The general aptitude or diſpoſition of this ſpecies of ſeed-veſſel to cleave or ſeparate for the purpoſe of diſperſing its ſeeds, diſtinguiſhes it not leſs remarkably than its texture from the pulpy or ſucculent fruits of the apple, berry, and cherry kind. This opening of the capſule for diſcharging

ging its ſeeds when the fruit is ripe, is either at the top, as in moſt plants; at the bottom, as in triglochin; at the ſide, through a pore or ſmall hole, as in campanula and orchis; horizontally, as in plantain, amaranthus, and anagallis; or longitudinally, as in convolvulus. All fruit that is jointed, opens at every one of the joints, each of which contains a ſingle ſeed. Capſules, in ſplitting, are divided, externally, into one or more pieces, called by Linnæus *valves*. The internal diviſions of the capſules are called *cells*, *loculamenta*: theſe, in point of number, are exceedingly diverſified; ſome having only one cell, as the primroſe; and others many, as the water lilly. Hence a capſule is termed *unilocular*, *bilocular*, *trilocular*, &c. according as it has one, two, three, &c. cells or cavities.

CAPSULÆ *Atrabiliariæ*, called alſo *glandulæ renales*, and *renes ſuccenturiati*. See ANATOMY *Index*.

CAPTAIN, a military officer, whereof there are ſeveral kinds, according to their commands.

CAPTAIN *of a Troop or Company*, an inferior officer who commands a troop of horſe or a company of foot, under a colonel. The duty of this officer is to be careful to keep his company full of able-bodied ſoldiers; to viſit their tents and lodgings, to ſee what is wanting; to pay them well; to cauſe them keep themſelves neat and clean in their clothes, and their arms bright. He has power in his own company of making ſerjeants, corporals, and lanſpeſades.

In the horſe and foot guards, the captains have the rank of colonels.

CAPTAIN *General*, he who commands in chief.

CAPTAIN *Lieutenant*, he who, with the rank of captain, but the pay of lieutenant, commands a troop or company in the name and place of ſome other perſon who is diſpenſed with, on account of his quality, from performing the functions of his poſt.

Thus the colonel being uſually captain of the firſt company of his regiment, that company is commanded by his deputy under the title of *Captain-Lieutenant*.

So in England, as well as in France, the king, queen, dauphin, princes, &c. have uſually the title of captain of the guards, *gens d'armes*, &c. the real duty of which offices is performed by captain-lieutenants.

CAPTAIN *Reformed*, one who, upon the reduction of the forces, has his commiſſion and company ſuppreſſed; yet is continued captain, either as ſecond to another, or without any poſt or command at all.

CAPTAIN *of a Ship of War*, the officer who commands a ſhip of the line of battle, or a frigate carrying 20 or more cannon. The charge of a captain in his majeſty's navy is very comprehenſive, in as much as he is not only anſwerable for any bad conduct in the military government, navigation, and equipment of the ſhip he commands, but alſo for any neglect of duty or ill management in his inferior officers, whoſe ſeveral charges he is appointed to ſuperintend and regulate.

On his firſt receiving information of the condition and quality of the ſhip he is appointed to command, he muſt attend her conſtantly, and haſten the neceſſary preparations to fit her for ſea. So ſtrict, indeed, are the injunctions laid on him by the lord high admiral, or commiſſioners of the admiralty, that he is forbid to lie out of his ſhip, from his arrival on board to the day of his diſcharge, unleſs by particular leave from the admiralty or from his commander in chief. He is enjoined to ſhow a laudable example of honour and virtue to the officers and men; and to diſcountenance all diſſolute, immoral, and diſorderly practices, and ſuch as are contrary to the rules of ſubordination and diſcipline; as well as to correct thoſe who are guilty of ſuch offences as are puniſhable according to the uſage of the ſea. He is ordered particularly to ſurvey all the military ſtores which are ſent on board, and to return whatever is deemed unfit for ſervice. His diligence and application are required to procure his complement of men; obſerving carefully to enter only ſuch as are fit for the neceſſary duty, that the government may not be put to unneceſſary expence. When his ſhip is fully manned, he is expected to keep the eſtabliſhed number of men complete, and ſuperintend the muſter himſelf, if there is no clerk of the check at the port. When his ſhip is employed on a cruiſing ſtation, he is expected to keep the ſea the whole length of time previouſly appointed; but if he is compelled by ſome unexpected accident to return to port ſooner than the time limited, he ought to be very cautious in the choice of a good ſituation for anchoring, ordering the maſter or other careful officers to ſound and diſcover the depths of water and dangers of the coaſt. Previous to any poſſibility of an engagement with the enemy, he is to quarter the officers and men to the neceſſary ſtations according to their office and abilities, and to exerciſe them in the management of the artillery, that they may be more expert in time of battle. His ſtation in the time of an engagement is on the quarter-deck: at which time he is expected to take all opportunities of annoying his enemy, and improving every advantage over him; to exhibit an example of courage and fortitude to his officers and crew; and to place his ſhip oppoſite to his adverſary in ſuch a poſition as that every cannon ſhall do effectual execution. At the time of his arrival in port, after his return from abroad, he is to aſſemble his officers, and draw up a detail of the obſervations that have been made during the voyage, of the qualities of the ſhip as to her trim, ballaſt, ſtowage, manner of ſailing, for the information and direction of thoſe who may ſucceed him in the command: and this account is to be ſigned by himſelf and officers, and to be returned to the reſident commiſſioner of the navy at the port where the ſhip is diſcharged.

CAPTAIN *of a Merchant-ſhip*, he who has the direction of the ſhip, her crew, and lading, &c. In ſmall ſhips and ſhort voyages, he is more ordinarily called the *maſter*. In the Mediterranean, he is called the *patroon*.—The proprietor of the veſſel appoints the captain or maſter: and he is to form the crew, and chooſe and hire the pilots, mates, and ſeamen; though, when the proprietor and maſter reſide on the ſame ſpot, they generally act in concert together.

CAPTAIN *Baſhaw*, or *Capondan Baſhaw*, in the polity of the Turks, ſignifies the Turkiſh high admiral. He poſſeſſes the third office of the empire, and is inveſted with the ſame power at ſea that the viſier has on ſhore. Soliman II. inſtituted this office in favour of the famous Barbaroſſa, with abſolute authority over the officers of the marine and arſenal, whom he may puniſh, caſhier, or put to death, as ſoon as he is without

out the Dardanelles. He commands in chief in all the maritime countries, cities, caſtles, &c. and, at Conſtantinople, is the firſt magiſtrate of police in the villages on the ſide of the Porte, and the canal of the Black ſea. The mark of his authority is a large Indian cane, which he carries in his hand, both in the arſenal and with the army.—The captain baſhaw enjoys two ſorts of revenues; the one fixed, the other caſual. The firſt ariſes from a capitation of the iſlands in the Archipelago, and certain governments in Natolia and Galipoli. The latter conſiſts in the pay of the men who die during a campaign; in a fifth of all prizes made by the begs; in the profits accruing from the labour of the ſlaves, whom he hires as rowers to the grand ſignior; and in the contributions he exacts in all places where he paſſes.

CAPTION, in *Scots Law*, a writ iſſuing under his majeſty's ſignet, in his majeſty's name, obtained at the inſtance of a creditor in a civil debt, commanding meſſengers at arms and other officers of the law to apprehend and impriſon the perſon of the debtor until he pay the debt.---It is alſo the name of a writ iſſued by the court of ſeſſion againſt the agents of the court, to return papers belonging to proceſſes or law ſuits, or otherwiſe to go to priſon.

CAPTIVE, a ſlave or a perſon taken from the enemy.

Formerly captives in war became the ſlaves of thoſe who took them; and though ſlavery, ſuch as obtained among the ancients, is now aboliſhed, ſome ſhadow of it ſtill remains in reſpect of priſoners of war, who are accounted the property of their captors, and have no right to liberty but by conceſſion from them. —The Romans uſed their captives with great ſeverity; their necks were expoſed to the ſoldiers to be trampled on, and their perſons afterwards ſold by public auction. Captives were frequently burnt in the funeral piles of the ancient warriors, as a ſacrifice to the infernal gods. Thoſe of royal or noble blood had their heads ſhaven, and their hair ſent to Rome to ſerve as decorations for female toys, &c. They were led in triumph loaded with chains through Rome, in the emperor's train, at leaſt as far as the foot of the Capitoline mount, for they were not permitted to aſcend the ſacred hill, but carried thence to priſon. Thoſe of the prime quality were honoured with golden chains on their hands and feet, and golden collars on their necks. If they made their eſcape, or killed themſelves, to avoid the ignominy of being carried in triumph, their images or effigies were frequently carried in their place.

CAPTIVITY, in a general ſenſe, the ſtate or condition of a captive.

CAPTIVITY, in ſacred hiſtory, a puniſhment which God inflicted upon his people for their vices and infidelities. The firſt of theſe captivities is that of Egypt, from which Moſes delivered them; after which, are reckoned ſix during the government of the judges; but the greateſt and moſt remarkable were thoſe of Judah and Iſrael, which happened under the kings of each of theſe kingdoms. It is generally believed, that the ten tribes of Iſrael never came back again after their diſperſion; and Joſephus and St Jerome are of this opinion: nevertheleſs, when we examine the writings of the prophets, we find the return of Iſrael from captivity pointed out in a manner almoſt as clear as that of the tribes of Benjamin and Judah: See Hoſea, i. 10, 11. Amos ix. 14. The captivities of Judah are generally reckoned four; the fourth and laſt of which fell in the year of the world 3416, under Zedekiah; and from this period begins the 70 years captivity foretold by Jeremiah.

Since the deſtruction of the temple by the Romans, the Hebrews boaſt that they have always had their heads or particular princes, whom they call *princes of the captivity*, in the eaſt and weſt. The princes of the captivity in the eaſt governed the Jews that dwelt in Babylon, Aſſyria, and Perſia; and the princes of the captivity in the weſt governed thoſe who dwelt in Judæa, Egypt, Italy, and in other parts of the Roman empire. He who reſided in Judæa commonly took up his abode at Tiberias, and aſſumed the name of *Roſchabboth*, "head of the fathers or patriarchs." He preſided in aſſemblies, decided in caſes of conſcience, levied taxes for the expences of his viſits, and had officers under him who were deſpatched through the provinces for the execution of his orders. As to the princes of the captivity at Babylon, or the eaſt, we know neither the original nor ſucceſſion of them. It only appears that they were not in being before the end of the ſecond century.

CAPTURE, a prize, or prey; particularly that of a ſhip taken at ſea. Captures made at ſea were formerly held to be the property of the captors after a poſſeſſion of twenty-four hours; but the modern authorities require, that before the property can be changed, the goods muſt have been brought into port, and have continued a night *intra præſidia*, in a place of ſafe cuſtody, ſo that all hope of recovering them was loſt.

CAPTURE alſo denotes an arreſt or ſeizure of a criminal, debtor, &c. at land.

CAPUA, in *Ancient Geography*, a very ancient city of Italy, in Campania, and capital of that diſtrict. It is famous for the abode of Hannibal the Carthaginian general after the battle of Cannæ, and where Livy accuſes him, but unjuſtly, of having enervated himſelf with pleaſures *. It ſtill retains the name, and is the ſee of an archbiſhop. It is ſeated on the river Volturno, in E. Long. 15. 5. N. Lat. 41. 7. The hiſtory of Capua is thus ſhortly deduced by Mr Swinburne. "It was a ſettlement of the Oſci long before the foundation of Rome. As the amazing fertility of the land and a lucrative commerce poured immenſe wealth upon its inhabitants, it became one of the moſt extenſive and magnificent cities in the world. With riches exceſſive luxury crept in, and the Capuans grew inſolent; but by their effeminacy they ſoon loſt the power of repelling thoſe neighbouring nations which their inſolence had exaſperated. For this reaſon Capua was continually expoſed to the neceſſity of calling in foreign aid, and endangering its ſafety by the uncommon temptations it offered to needy auxiliaries. The Roman ſoldiers ſent to defend Capua were on the point of making it their prey, and often the voice of the Roman people was loud for a removal from the barren unwholeſome banks of the Tiber to the garden of Italy, near thoſe of the Volturno. Through well-founded jealouſy of the ambition of Rome, or, as Livy and other partial writers term it, natural inconſtancy,

* See *Carthage*.

the Capuans warmly eſpouſed the quarrel of Carthage: Hannibal made Capua his winter quarters after the campaign of Cannæ; and there, if we are to believe hiſtorians, his rough and hitherto invincible ſoldiers were enervated by pleaſure and indolence.

“ When through a failure of ſupplies from Carthage Hannibal was under a neceſſity of remaining in Bruttium, and leaving the Capuans to defend themſelves, this city, which had been long inveſted, was ſurrendered at diſcretion to the conſuls Appius Claudius and Q. Fulvius Flaccus. The ſenators were put to death, the nobles impriſoned for life, and all the citizens ſold and diſperſed. Vibius, the chief of Hannibal's friends, avoided this ignominious fate, and eſcaped from the cruel vengeance of the Romans by a voluntary death.---When the mob inſiſted upon the gates being thrown open to the enemy, Vibius aſſembled his ſteady aſſociates, and ſat down with them to a ſuperb banquet, after which each of the gueſts ſwallowed a poiſonous draught, and expired in full poſſeſſion of their freedom. The buildings were ſpared by the victor; and Capua was left to be merely a harbour for the huſbandmen of the plain, a warehouſe for goods, and a granary for corn; but ſo advantageous a ſituation could not long be neglected; colonies were ſent to inhabit it, and in proceſs of time it regained a degree of importance.

“ Genſeric the Vandal was more cruel than the Roman conquerors had been; for he maſſacred the inhabitants, and burnt the town to the ground. Narſes rebuilt it; but in 841 it was totally deſtroyed by an army of Saracens, and the inhabitants driven into the mountains. Some time after the retreat of theſe ſavage invaders, the Lombards ventured down again into the plain; but not deeming their force adequate to the defence of ſo large a circuit as the old city, they built themſelves a ſmaller one on the river, and called it Capua.—They choſe the ſite of Caſilinum, famous in the ſecond Punic war, for the reſiſtance made by its garriſon againſt Hannibal. Since the foundation of the new city, Old Capua has remained in ruins.

“ In 856, Landulph formed here an independent earldom diſmembered from the duchy of Benevento, and in the courſe of a few generations Capua acquired the title of a principality. In the 11th century, the Normans of Averſa expelled the Lombard race of princes, and Richard their chief became prince of Capua; the grandſon of Tancred of Hauteville drove out the deſcendants of Richard, and united this ſtate to the reſt of his poſſeſſions.

“ Capua is at preſent a neat little city, fortified according to the rules of modern art, and may be conſidered as the key of the kingdom; though far removed from the frontier, it is the only fortification that really covers the approach to Naples.”

CAPUCHINS, religious of the order of St Francis in its ſtricteſt obſervance; deriving their name from *capuce*, or *capuchon*, a ſtuff cap, or cowl, wherewith they cover their heads. They are clothed with brown or gray; always barefooted; are never to go in a coach, nor ever ſhave their beard.---The Capuchins are a reform made from the order of Minors, commonly called *Cordeliers*, ſet on foot in the 16th century by Matthew Baſchi, a religious obſervant of the monaſtery of Monteſiaſcone; who, being at Rome, was advertiſed ſeveral times from heaven, to practiſe the rule of St Francis to the letter. Upon this he made application to Pope Clement in 1525; who gave him permiſſion to retire into a ſolitude, with as many others as choſe to embrace the ſtrict obſervance. In 1528, they obtained the pope's bull. In 1529, the order was brought into complete form: Matthew was elected general, and the chapter made conſtitutions. In 1543, the right of preaching was taken from the Capuchins by the pope: but in 1545 it was reſtored to them again with honour. In 1578, there were already 17 general chapters in the order of Capuchins.

CAPUT, the head. See HEAD.

CAPUT *baroniæ*, the head of the barony, in ancient cuſtoms, denotes the ancient or chief ſeat or caſtle of a nobleman, where he made his uſual reſidence, and held his court; ſometimes alſo called *caput honoris*, or the head of the honour. The caput baroniæ could not be ſettled in dowry; nor could it be divided among the daughters, in caſe there was no ſon to inherit; but was to deſcend entire to the eldeſt daughter, *cæteris filiabus aliunde ſatisfactis*.

CAPUT *gallinaginis*, in *Anatomy*, is a kind of ſeptum, or ſpongy border, at the extremities or apertures of each of the *veſiculæ ſeminales*; ſerving to prevent the ſeed coming from one ſide, from ruſhing upon, and ſo ſtopping, the diſcharge of the other.

CAPUT *lupinum*. Anciently an outlawed felon was ſaid to have *caput lupinum*, and might be knocked on the head like a *wolf*, by any one that ſhould meet him; becauſe, having renounced all law, he was to be dealt with as in a ſtate of nature, when every one that ſhould find him might ſlay him; yet now, to avoid ſuch inhumanity, it is holden that no man is entitled to kill him wantonly and wilfully; but in ſo doing he is guilty of murder, unleſs it is done in the endeavour to apprehend him.

CAPUT *Mortuum*, a Latin name given to fixed and exhauſted reſiduums remaining in retorts after diſtillations. As theſe reſiduums are very different, according to the ſubſtances diſtilled, and the degree of heat employed, they are by the more accurate modern chemiſts particularly ſpecified by adding a term denoting their qualities; as *earthy reſiduum*, *charry reſiduum*, *ſaline reſiduum*, &c.

CARABINE, a fire arm ſhorter than a muſket, carrying a ball of 24 in the pound, borne by the light horſe, hanging at a belt over the left ſhoulder. The barrel is two feet and a half long; and is ſometimes furrowed ſpirally within, which is ſaid to add to the range of the piece.

CARABINEERS, regiments of light horſe, carrying longer carabines than the reſt, and ſometimes uſed on foot.

CARABUS. See ENTOMOLOGY *Index*.

CARACALLA, M. ANTONINUS BASSIANUS, emperor after his father Severus in 211, put the phyſicians to death for not deſpatching his father, as he would have had them. He killed his brother Geta; and put Papinianus to death, becauſe he would not defend nor excuſe his parricide. In ſhort, it is ſaid that 20,000 perſons was maſſacred by his order. He married Julia, his father's widow. Going to Alexandria, he ſlew the inhabitants, and applied to the magicians and aſtrologers. At laſt, going from Edeſſa to Meſopotamia, one of his captains ſlew him, by order of Macrinus, who ſucceeded him. He died after he had reigned ſomewhat more than ſix years.

Caracalla, in antiquity, a long garment, having a ſort of capuchin, or hood a-top, and reaching to the heels; worn equally among the Romans by the men and the women, in the city and the camp. Spartian and Xiphilian repreſent the emperor Caracalla as the inventor of this garment, and hence ſuppoſe the appellation *Caracalla* was firſt given him. Others, with more probability, make the caracalla originally a Gallic habit, and only brought to Rome by the emperor above-mentioned, who firſt enjoined the ſoldiery to wear it. The people call it *antoninian*, from the ſame prince, who had borrowed the name of Antoninus. The caracalla was a ſort of caſſock, or ſurtout. Salmaſius, Scaliger, and after them Du Cange, even take the name *caſaque* to have been formed from that of *caraque*, for *caracalla*. This is certain from St Jerome, that the caracalla, with a retrenchment of the capuchin, became an eccleſiaſtical garment. It is deſcribed as made of ſeveral pieces cut and ſewed together, and hanging down to the feet; but it is more than probable there were ſome made ſhorter, eſpecially out of Rome, otherwiſe we do not ſee how it could have fitted the ſoldiers purpoſes.

CARACCAS, a diſtrict of Terra Firma in South America, belonging to the Spaniards. The coaſt is rocky and mountainous, interſperſed with ſmall fertile valleys; ſubjected at certain ſeaſons of the year to dry north-weſt winds, but bleſſed in general with a clear air and wholeſome climate. A very great illicit trade is carried on by the Engliſh and Dutch with this province, notwithſtanding all the vigilance of the Spaniards, who have ſcouts perpetually employed, and breaſtworks raiſed in all the valleys. A vaſt number of cacao trees are cultivated in this province; and it is reckoned that the crop of cacao produced here amounts to more than 100,000 fanegas of 110 pounds each. The country of Santa Fe conſumes 20,000; Mexico a little more; the Canaries a ſmall cargo; and Europe from 50 to 60,000. The cultivation of the plant employs 10 or 12,000 negroes. Such of them as have obtained their liberty have built a little town called *Nirva*, into which they will not admit any white people. The chief town is likewiſe called *Caraccas*, and is ſituated in N. Lat. 10. 10. Dampier ſays it ſtands at a conſiderable diſtance from the ſea; is large, wealthy, and populous; and extremely difficult of acceſs, by reaſon of the ſteep and craggy hills over which an enemy muſt take his route. The commerce of this town, to which the bay of Guaira at two leagues diſtance ſerves for a harbour, was for a long time open to all the ſubjects of the Spaniſh monarchy, and is ſtill ſo to the Americans; but the Europeans are not ſo well treated. In 1728 a company was formed at St Sebaſtian, which obtained an excluſive right of maintaining connexions with this part of the new world. Four or five ſhips which they diſpatch every year, ſail from thence, but they return to Cadiz.

CARACCI, Lewis, Augustine, and Hannibal, three celebrated painters of the Lombard ſchool, all of Bologna. Lewis was born in 1555; and was couſin-german to Auguſtine and Hannibal, who were brothers, the ſons of a taylor, who was yet careful to give them a liberal education. They were both diſciples of their couſin Lewis. Auguſtine gained a knowledge of mathematics, natural philoſophy, muſic, poetry, and moſt of the liberal arts; but, though painting was his principal purſuit, he learned the art of engraving from Cornelius Cort, and ſurpaſſed all the maſters of his time. Hannibal, again, never deviated from his pencil. —Theſe three painters, at length, having reaped all the advantages they could by contemplation and practice, formed a plan of aſſociation, continued always together, and laid the foundation of that celebrated ſchool which has ever ſince been known by the name of *Caracci's academy*. Hither all the young ſtudents, who had a view of becoming maſters, reſorted to be inſtructed in the rudents of painting; and here the Caracci taught freely, and without reſerve, all that came. Lewis's charge was to make a collection of antique ſtatues and baſs reliefs. They had deſigns of the beſt maſters, and a collection of curious books on all ſubjects relating to their art; and they had a ſkilful anatomiſt always ready to teach what belonged to the knitting and motions of the muſcles, &c. There were often diſputations in the academy; and not only painters, but men of learned profeſſions, propoſed queſtions, which were always decided by Lewis. Every body was well received; and though ſtated hours were allotted to treat of different matters, yet improvements might be made at all hours by the antiquities and the deſigns which were to be ſeen.

The fame of the Caracci reaching Rome, the cardinal Farneſe ſent for Hannibal thither, to paint the gallery of his palace. Hannibal was the more willing to go, becauſe he had a great deſire to ſee Raphael's works, with the antique ſtatues and baſs reliefs. The guſto which he took there from the ancient ſculpture, made him change his Bolognian manner for one more learned but leſs natural in the deſign and in the colouring.—Auguſtine followed Hannibal, to aſſiſt him in his undertaking of the Farneſe gallery; but the brothers not rightly agreeing, Farneſe ſent Auguſtine to the court of the duke of Parma, where he died in the year 1602, being only 45 years of age. His moſt celebrated piece of painting is that of the Communion of St Jerome, in Bologna.

In the mean while, Hannibal continued working in the Farneſe gallery at Rome; and, after inconceivable pains and care, finiſhed the paintings in the perfection in which they are now to be ſeen. He hoped that the cardinal would have rewarded him in ſome proportion to the excellence of his work, and the time it took him up, which was eight years; but he was diſappointed. The cardinal, influenced by an ignorant Spaniard, his domeſtic, gave him but a little above 200l. though it is certain he deſerved more than twice as many thouſands. When the money was brought him, he was ſo ſurpriſed at the injuſtice done him, that he could not ſpeak a word to the perſon who brought it. This confirmed him in a melancholy to which his temper naturally inclined, and made him reſolve never more to touch his pencil; which reſolution he had undoubtedly kept if his neceſſities had not compelled him to break it. It is ſaid, that his melancholy gained ſo much upon him, that at certain times it deprived him of the uſe of his ſenſes. It did not, however, put a ſtop to his amours; and his debauches at Naples, whither he had retired for the recovery of his health, brought a diſtemper upon him of which he died in 1609, when he was 49 years of age. His veneration for Raphael was ſo great, that it was his deathbed requeſt to be buried in the ſame tomb with him: which was accordingly done, in the pantheon or rotunda at Rome. There are extant ſeveral prints of the bleſſed Virgin, and ſome other ſubjects, etched by the hand of this incomparable artiſt. He is ſaid to have been a friendly, plain, honeſt, and open-hearted man; very communicative to his ſcholars, and ſo extremely kind to them, that he generally kept his money in the ſame box with his colours, where they might have recourſe to either as they had occaſion.

While Hannibal Caracci worked at Rome, Lewis was courted from all parts of Lombardy, eſpecially by the clergy, to make pictures in their churches: and we may judge of his capacity and facility, by the great number of pictures he made, and by the preference that was given him to other painters. In the midſt of theſe employments Hannibal ſolicited him to come and aſſiſt him in the Farneſe gallery; and ſo earneſtly, that he could not avoid complying with his requeſt. He went to Rome; corrected ſeveral things in that gallery; painted a figure or two himſelf; and then returned to Bologna, where he died in 1619, aged 64.

CARACOL, in the manege, the half turn which a horſeman makes, either to the right or left.—In the army, the horſe always makes a caracol after each diſcharge, in order to paſs the rear of the ſquadron.

Caracol, in *Architecture*, denotes a ſtaircaſe in a helix or ſpiral form.

CARACOLI, a kind of metal of which the Caribbees, or natives of the Leſſer Antilles, make a ſort of ornament in the form of a creſcent, which they alſo call *caracoli*.—This metal comes from the main land; and the common opinion is, that it is a compound of ſilver, copper, and gold, ſomething like the Corinthian braſs among the ancients. Theſe metals are ſo perfectly mixed and incorporated together, that the compound which reſults from them, it is ſaid, has a colour that never alters, how long ſoever it remains in the ſea or under ground. It is ſomewhat brittle: and they who work at it are obliged to mix a large proportion of gold with it, to make the compound more tough and malleable.

CARACT, or Carat, the name of that weight which expreſſes the degree of fineneſs that gold is of. The word is alſo written *carract*, *carrat*, *karract*, and *karrat*. Its origin is conteſted: but the moſt probable opinion is that of Kennet, who derives it from *carecta*, a term which anciently denoted any weight, and came not till of latter days to be appropriated to that which expreſſes the fineneſs of gold, and the gravity of diamonds.

Theſe carrats are not real determinate weights, but only imaginary. The whole maſs, be the weight what it will, is conceived to be divided into 24 carats; and as many 24th parts as it contains of pure gold, it is called *gold of so many carats* or *so many carats fine*. Thus, gold of 18 carats is a mixture, of which 18 parts are pure gold, and the other ſix an inferior metal, &c. This is the common way of reckoning in Europe, and at the gold mines in the Spaniſh Weſt Indies, but with ſome variation in the ſubdiviſion of the carat: among us, it is divided into four grains; among the Germans, into 12 parts; and by the French, according to Mr Helot, into 32. The Chineſe reckon by a different diviſion called *touches*, of which the higheſt number, or that which denotes pure gold, is 100; ſo that 100 touches correſpond to our 24 carats, &c.

Caract is alſo a certain weight which goldſmiths and jewellers uſe wherewith to weigh precious ſtones and pearls.—In this ſenſe, the word is by ſome ſuppoſed to be derived from the Greek κεράτιον. a fruit which the Latins call *siliqua*, and we *carob bean*; each of which may weigh about four grains, of wheat whence the Latin *siliqua* has been uſed for a weight of four grains. This caract weighs four grains, but they are ſometimes lighter than the grains, of other weights. Each of theſe grains is ſubdivided in $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, &c.

CARACTACUS, a renowned king of the ancient Britiſh people called *Silures*, inhabiting South Wales. Having valiantly defended his country ſeven years againſt the Romans, he was at length defeated; and flying to Cartiſmunda, queen of the Brigantes (inhabitants of Yorkſhire), was by her treacherouſly delivered up to the Romans, and led in triumph to the emperor Claudius then at York; where his noble behaviour, and heroic but pathetic ſpeech, obtained him not only his liberty, but the eſteem of the emperor, A. D. 52.

CARAGROUTH, in commerce, a ſilver coin of the empire, weighing nine drachms. It goes at Conſtantinople for 120 aſpers. There are four ſorts of them, which are all equally current and of the ſame value.

CARAITES, in the eccleſiaſtical hiſtory of the Jews, a religious ſect among that people, whereof there are ſtill ſome ſubſiſting in Poland, Ruſſia, Conſtantinople, Cairo, and other places of the Levant, whoſe diſtinguiſhing tenet and practice it is, to adhere cloſely to the words and letter of the Scripture, excluſive of allegories, traditions, and the like.

Leo of Modena, a rabbin of Venice, obſerves, that of all the hereſies among that people, before the deſtruction of the temple, there is none now left but that of the *Caraim*, a name derived from *Micra*, which ſignifies the pure text of the Bible, becauſe of their keeping to the Pentateuch, obſerving it to the letter, and rejecting all interpretations, paraphraſes, and conſtitutions of the rabbins. Aben Ezra, and ſome other rabbins, treat the Caraites as Sadducees; but Leo de Juda calls them, more accurately, Sadducees reformed; becauſe they believe the immortality of the ſoul, paradiſe, hell, reſurrection, &c. which the ancient Sadducees denied. He adds, however, that they were doubtleſs originally real Sadducees, and ſprung from among them.

M. Simon, with more probability, ſuppoſes them to have riſen hence; that the more knowing among the Jews oppoſing the dreams and reveries of the rabbins, and uſing the pure texts of Scripture to refute their groundleſs traditions, had the name of *Caraim* given them; which ſignifies as much as the barbarous Latin *Scripturarii*; i. e. people attached to the text of Scripture. The other Jews gave them the odious name Sadducees, from their agreement with thoſe ſectaries on the head of traditions. Scaliger, Voſſius, and Spanheim.

heim, rank the Caraites among the Sabeans, Magi, Manichees, and Muſſulmans, but by miſtake: Wolfgang, Fabricius, &c. ſay the Sadduces and Eſſeni were called Caraites, in oppoſition to the Phariſees; others take them for the doctors of the law ſo often mentioned in the Goſpel: but theſe are all conjectures, Joſephus and Philo make no mention of them; which ſhows them to be more modern than either of thoſe authors. In all probability, this ſect was not formed till after the collection of the ſecond part of the Talmud, or the Gemera; perhaps not till after the compiling of the Miſchna in the third century. The Caraites themſelves pretend to be the remains of the ten tribes led captive by Shalmaneſer. Wolfius, from the Memoirs of Mardacheus, a Caraite, refers their origin to a maſſacre among the Jewiſh doctors under Alexander Jannæus, their king, about 100 years before Chriſt: becauſe Simon, ſon of Schetach, and the queen's brother, making his eſcape into Egypt, there forged his pretended traditions; and, at his return to Jeruſalem, publiſhed his viſions; interpolating the law after his own fancy, and ſupporting his novelties on the notices which God, he ſaid, had communicated by the mouth of Moſes, whoſe depoſitary he was: he gained many followers; and was oppoſed by others, who maintained, that all which God had revealed to Moſes was written. Hence the Jews become divided into two ſects, the Caraites and Traditioners: among the firſt, Juda, ſon of Tabbai, diſtinguiſhed himſelf; among the latter, Hillel. Wolfius reckons not only the Sadducees, but alſo the Scribes, in the number of Caraites. But the addreſs of the Phariſees prevailed againſt them all; and the number of Caraites decreaſed: Anan, indeed, in the eighth century, retrieved their credit a little; and Rabbi Schalomon in the ninth. They ſucceeded pretty well till the fourteenth; but ſince that time they have been declining.

The Caraites are but little known; their works coming only into very few hands, even among the greateſt Hebraiſts. Buxtorf never ſaw more than one; Selden two; but Mr Trigland ſays, he has recovered enough to ſpeak of them with aſſurance. He aſſerts, that ſoon after the prophets had ceaſed, the Jews became divided on the ſubject of works, and ſupererogation: ſome maintaining their neceſſity from tradition; whilſt others, keeping cloſe to the written law, ſet them aſide; and it was from theſe laſt that Caraitiſm commenced. He adds, that after the return from the Babyloniſh captivity, the obſervation of the law being to be re-eſtabliſhed, there were ſeveral practices found proper for that end; and theſe once introduced, were looked upon as eſſential, and appointed by Moſes; which was the origin of Phariſaiſm: as a contrary party, continuing to keep cloſe to the letter, founded Caraitiſm.

The modern Caraites, Leo of Modena obſerves, have their ſynagogues and ceremonies; they pretend to be the ſole proper Jews, or obſervers of the laws of Moſes; calling the reſt by the term *Rabbanim*, or *followers of the Rabbins*: theſe hate the Caraites mortally; refuſing to ally or even to converſe with them, and treating them as *mamzerim*, baſtards; becauſe of their rejecting the conſtitutions of the rabbins relating to marriages, repudiations, purifications of women, &c. This averſion is ſo great, that if a Caraite ſhould become a Rabbiniſt, he would never be received by the other Jews.

The Caraites, however, do not abſolutely reject all kinds of traditions; but only ſuch as do not appear well grounded. Selden, who is very expreſs on this point, in his Uxor Hebraica, obſerves, that, beſides the mere text, they have certain interpretations, which they call hereditary, and which are proper traditions. Their theology only ſeems to differ from that of the other Jews, in that it is purer, and clearer of ſuperſtition; they give no credit to the explications of the Cabbaliſts, chimerical allegories, nor to any conſtitutions of the Talmud, but what are conformable to the Scripture, and may be drawn from it by juſt and neceſſary conſequences.

Peringer obſerves of the Caraites in Lithuania, that they are very different, both in aſpect, language, and manners, from the Rabbiniſts, wherewith the country abounds. Their mother tongue is the Turkiſh; and this they uſe in their ſchools and ſynagogues. In viſage they reſemble the Mahometan Tartars. Their ſynagogues are placed north and ſouth; and the reaſon they give for it is, that Shalmaneſer brought them northward: ſo that, in praying, to look to Jeruſalem, they muſt turn to the ſouth. He adds, that they admit all the books of the Old Teſtament; contrary to the opinion of many of the learned, who hold that they reject all but the Pentateuch.

Caleb, a Caraite, reduces the difference between them and the Rabbiniſts to three points: 1. In that they deny the oral law to have come from Moſes, and reject the Cabbala. 2. In that they abhor the Talmud. 3. In that they obſerve the feaſts, as the ſabbaths, &c. much more rigorouſly than the Rabbins do. To this may be added, that they extend the degrees of affinity, wherein marriage is prohibited, almoſt to infinity.

CARAMANIA, a conſiderable province of Turkey in Aſia, in the ſouth part of Natolia. Bajazet united this province to his empire about the year 1488, and ſince that time it has continued in the poſſeſſion of the Turks. Satalia was the capital city, but is now much decayed.

CARAMANTA, a town of South America, and capital of the province of the ſame name in Terra Firma, and in the audience of Santa Fe. W. Long. 72. 35. N. Lat. 5. 18. The province of Caramanta is extended on both ſides the river Cauca; and is bounded on the north by the diſtrict of Carthagena, on the eaſt by New Grenada, on the ſouth by Popayan, and on the weſt by Popayan and by the audience of Panama. It is a valley ſurrounded on every ſide by very high mountains.

CARANGA, an inconſiderable iſland near Bombay in the Eaſt Indies. It affords nothing but ſome rice, fowls, and goats, for that market.

CARANNA, or Karanna, a very ſcarce gum which comes from New Spain. It is ſaid to poſſeſs many extraordinary medical virtues, but the preſent practice takes no notice of it.

CARANUS, the firſt king of Macedon, and the ſeventh of the race of the Heraclidæ. See Macedonia.

CARARA, a weight at Leghorn, and in other parts of Italy, uſed in the ſale of wool and cod fiſh, equivalent to 60 pounds of that country.

CARAT. See CARACT.

CARAVAGGIO, MICHAEL ANGELO. See ANGELO.

CARAVAN, or KARAVANNE, in the eaſt, ſignifies a company or aſſembly of travellers and pilgrims, and more particularly of merchants, who, for their greater ſecurity, and in order to aſſiſt each other, march in a body through the deſerts, and other dangerous places, which are infeſted with Arabs or robbers.

There are four regular caravans which go yearly to Mecca; the firſt from Damaſcus, compoſed of the pilgrims from Europe and Aſia; the ſecond from Cairo, from the Mahomedans of Barbary; the third from Zibith, a place near the mouth of the Red Sea, where thoſe of Arabia and India meet; the fourth from Babylon, where the Perſians aſſemble. Moſt of the inland commerce of the Eaſt is carried on by caravans. The late czar Peter the Great eſtabliſhed a trade between Ruſſia and China by means of a caravan. M. Bougnon, geographer to the duke of Lorrain, has given a treatiſe of the caravans of merchants in Aſia; wherein he ſhows of what they are compoſed, how many ſorts there are; the ſeveral uſes of the different ſorts of animals in them; the prices given for them, the officers and men appointed to conduct them, and the pay of each, with their manner of marching, halting, fighting, retreating, &c. Caravans of this kind are large convoys of armed men, merchants, and travellers, with divers ſorts of animals for the carriage of their proviſions. There are commonly four chief officers of a caravan, viz. the caravan bachi, or chief; the captain guide; captain of reſt; and captain of diſtribution. The firſt has abſolute command over all the reſt: the ſecond is abſolute in the march; the office of the third only commences when the caravan ſtops and makes a ſtay: to the fourth it belongs to diſpoſe of every part of the corps, in caſe of an attack or battle; he has alſo the inſpection over the diſtribution of proviſions, which is made under him by ſeveral diſtributors, who give ſecurity to the maſter of the caravan, and have each of them a certain number of perrſons, elephants, dromedaries, &c. to take care of at their own peril. The treaſurer of the caravan makes a fifth officer. who has under him ſeveral agents and interpreters, who keep journals of all that paſſes, for the ſatisfaction of thoſe concerned in fitting out the caravan.

Any dealer is at liberty to form a company, in order to make a caravan. He in whoſe name it is raiſed, is conſidered as the caravan bachi, or chief of the caravan. unleſs he appoint ſome other in his place. If there are ſeveral merchants equally concerned, they elect a caravan bachi; after which, they appoint officers to conduct the caravan, and decide all controverſies that may ariſe during the journey.

There are alſo ſea caravans eſtabliſhed on the ſame footing, and for the ſame purpoſe: ſuch is the caravan of veſſels from Conſtantinople to Alexandria.

CARAVANSERA, or KARAVANSERA, a place appointed for receiving and loading the caravans.

It is commonly a large ſquare building, in the middle of which there is a very ſpacious court; and under the arches or piazzas that ſurround it there runs a bank, raiſed ſome feet above the ground, where the merchants, and thoſe who travel with them in any capacity, take up their lodgings as well as they can; the beaſts of burden being tied to the foot of the bank. Over the gates that lead into the court, there are ſometimes little rooms, which the keepers of the caravanſeras let out at a very high price to ſuch as have a mind to be private.

The caravanſeras in the eaſt are ſomething of the nature of the inns in Europe; only that you meet with little accommodation either for man or beaſt, but are obliged to carry almoſt every thing with you: there is never a caravanſera without a well, or ſpring of water. Theſe buildings are chiefly owing to the charity of the Mohometans: they are eſteemed ſacred dwellings, where it is not permitted to inſult any perſon, or to pillage any of the effects that are depoſited there. There are alſo caravanſeras where moſt things may be had for money; and as the profits of theſe are conſiderable, the magiſtrates of the cities to whoſe juriſdiction they belong, take care to ſtore them well. There is an inſpector, who, at the departure of each caravan, fixes the price of the night's lodging, from which there is no appeal.

CARAVANSERASKIER, the ſteward or keeper of a CARAVANSERA. He keeps an account of all the merchandiſes that are ſold upon truſt, and demands the payments of the ſums due to the merchants for what has been ſold in the caravanſera, on the ſeller's paying two per cent.

CARAVEL; thus they call a ſmall veſſel on the coaſt of France, which goes to fiſh for herring on the banks. They are commonly from 25 to 30 tons burden. Thoſe which are deſigned for the ſame fiſhery in the Britiſh channel are called by the French *trinquarts*; theſe are from 12 to 15 tons burden.

CARAWAY. See CARUM, BOTANY *Index*.

CARBONADE, or CARBONADO, in cookery; fleſh, fowl, or the like, ſeaſoned and broiled on the coals.

CARBUNCLE, in *Natural Hiſtory*, a very elegant gem, whoſe colour is deep red, with an admixture of ſcarlet.

This gem was known among the ancients by the name of *anthrax*. It is uſually found pure and faultleſs, and is of the ſame degree of hardneſs with the ſapphire: it is naturally of an angular figure; and is found adhering by its baſe, to a heavy and ferruginous ſtone of the emery kind: its uſual ſize is near a quarter of an inch in length, and two-thirds of that in diameter in its thickeſt parts: when held up againſt the ſun, it loſes its deep tinge, and becomes exactly of the colour of a burning charcoal, whence the propriety of the name which the ancients gave it. It bears the fire unaltered, not parting with its colour, nor becoming at all the paler by it. It is found only in the Eaſt Indies, ſo far as is yet known; and there but very rarely.

CARBUNCLE, or *Anthrax*, in *Medicine*, an inflammation which ariſes, in time of the plague, with a veſicle or bliſter almoſt like that produced by burning.

CARBUNCLE, in *Heraldry*, a charge or bearing, conſiſting of eight raddi, four whereof make a common croſs, and the other four a ſaltier.

Some call theſe radii *buttons*, or ſtaves, becauſe round, and enriched with buttons, or pearled like pilgrims ſtaves, and frequently tipped or terminated with flower-de-luces;

de-luces: others blazon them, royal ſcepters, placed in ſaltier, pale and feſſe.

CARCASSE, or CARCUS, in the art of war, an iron caſe, or hollow capacity, about the bigneſs of a bomb, of an oval figure, made of ribs of iron, filled with combuſtible matters, as meal powder, ſaltpetre, ſulphur, broken glaſs, ſhavings of horn, turpentine, tallow, &c. It has two or three apertures out of which the fire is to blaze, and the deſign of it is to be thrown out of a mortar, to ſet houſes on fire, and do other execution. It has the name *carcaſſe*, becauſe the circles which paſs from one ring or plate to the other ſeem to repreſent the ribs of a human carcaſe.

CARCASSONNE, an ancient city of France, in Lower Languedoc, with a biſhop's ſee. It is divided into the upper and lower town. They are both ſurrounded with walls: and though their ſituations are different, they are both watered by the river Aude. The upper town is ſeated on a hill, with a caſtle that commands it as well as the lower town. It is ſtrong, not only by its ſituation on a craggy rock, but alſo by ſeveral large towers which are joined to its walls, and which render it of difficult acceſs. The cathedral church is remarkable for nothing but its antiquity. The lower town is large, and built after the modern taſte. The ſtreets are very ſtraight, and lead to a large ſquare in the middle, from whence may be ſeen the four gates of the town. There is here a manufacture of cloth. The neighbouring country is full of olive-trees; and in the mountains there is a fine marble, commonly called *marble of Languedoc*. E. Long. 2. 25. N. Lat. 43. 11.

This place bore a conſiderable ſhare in that celebrated cruſade undertaken againſt the Albigenſes in the beginning of the 13th century, and which forms one of the moſt aſtoniſhing inſtances of ſuperſtition and of atrocious barbarity to be found in the annals of the world. When the royal power was nearly annihilated, during the reigns of the laſt kings of the Carlovingian race in France, moſt of the cities of Languedoc erected themſelves into little independent ſtates, governed by their own princes. Carcaſſonne was then under the dominion of viſcounts. At the time when Pope Innocent III. patronized and commanded the proſecution of hoſtilities againſt the Albigenſes for the crime of hereſy, Raymond the reigning viſcount was included in that proſcription. Simon de Montfort, general of the army of the church, inveſted the city of Carcaſſonne in 1209. The inhabitants, terrified at the fate of ſeveral other places where the moſt dreadful maſſacres had been committed, demanded leave to capitulate; but this act of mercy was only extended to them under a condition equally cruel, incredible, and unparalleled in hiſtory, if we are not compelled to believe it by the unanimous teſtimony of all the cotemporary writers. The people found in the place were all obliged, without deſtinction of rank or ſex, to evacuate it in a ſtate of nudity; and Agnes the viſcounteſs was not exempted, though young and beautiful, from this ignominious and ſhocking puniſhment. "On les fit ſortir tout nuds de la ville de Carcaſſonne (ſays an ancient author) afin qu'ils receuſſent de la hente, en montrant ces parties du corps que la puretè de la langue n'exprime point, deſquelles ils avoint abuſe, et ſ'en etoient ſervis dans des crimes execrables." It ſeems by this imputation that the Albigeois were accuſed by their enemies of ſome enormities, probably unjuſt, and ſimilar to thoſe which religious emnity and prejudice have attributed to the followers of Zinzendorf in the preſent century.

CARCERES, in the ancient Circenſian games, were incloſures in the circus, wherein the horſes were reſtrained till the ſignal was given for ſtarting, when by an admirable contrivance, they all at once flew open.

CARCHEMISH, in *Ancient Geography*, a town lying upon the Euphrates, and belonging to the Aſſyrians. Necho king of Egypt took it from the king of Aſſyria, 2 Chr. xxxv. 20. Necho left a garriſon in it, which was taken and cut to pieces, in the fourth year of Jehoiachin king of Judah, by Nebuchadnezzar king of Babylon, 2 Kings xxiii. 29. Iſaiah (x. 9.) ſpeaks of Carchemiſh, and ſeems to ſay, that Tiglath-pileſer made a conqueſt of it, perhaps from the Egyptians. This is thought to be the ſame city with that called Circeſium by the Greeks and Latins.

CARCINOMA, in *Medicine*; the ſame with CANCER. See MEDICINE and SURGERY *Index*.

CARD, among artificers, an inſtrument conſiſting of a block of wood, beſet with ſharp teeth, ſerving to arrange the hairs of wool, flax, hemp, and the like: there are different kinds of them, as hand-cards, ſtock-cards, &c. They are made as follows:

A piece of thick leather, of the ſize intended for the card, is ſtrained in a frame for that purpoſe; and then pricked full of holes, into which the teeth or pieces of iron wire are inſerted. After which the leather is nailed by the edges to a flat piece of wood, in the form of an oblong ſquare, about a foot in length, and half a foot in breadth, with a handle placed in the middle of one of the longer ſides.

The teeth are made in the following manner. The wire being drawn of the ſize intended, a ſkain or number of wires are cut into proper lengths by means of a gauge, and then doubled in a tool contrived for that purpoſe: after which they are bent into the proper direction by means of another tool; and then placed in the leather, as mentioned above.

CARDS, among gameſters, little pieces of fine thin paſteboard of an oblong figure, of ſeveral ſizes; but moſt commonly in Britain, three inches and a half long and two and a half broad, on which are painted ſeveral points and figures.

The moulds and blocks for making cards are exactly like thoſe that were uſed for the firſt printed books. They lay a ſheet of wet or moiſt paper on the block, which is very ſlightly done over with a ſort of ink made of lamp-black diluted in water, and mixed with ſome ſtarch to give it a body. They afterwards rub it off with a round liſt. The court-cards are coloured by means of ſeveral patterns, ſtyled *ſtane-files*. Theſe conſiſt of papers cut through with a penknife; and in theſe apertures they apply ſeverally the various colours, as red, black, &c. Theſe patterns are painted with oil-colours, that the bruſhes may not wear them out; and when the pattern is laid on the paſteboard, they ſlightly paſs over it a bruſh full of colour, which, leaving it within the openings, forms the face or figure of the card.

Among ſharpers, divers ſorts of falſe and fraudulent cards have been contrived; as, 1. *Marked* cards, where the aces, kings, queens, knaves, are marked on the corners of the backs with ſpots of different number and order, either with clear water or water tinged with pale Indian ink, that thoſe in the ſecret may diſtinguiſh them. Aces are marked with ſingle ſpots on two corners oppoſite diagonally: kings with two ſpots at the ſame corners: knaves with the ſame number tranſverſed. 2. *Breef* cards, thoſe which are longer or broader than the reſt: chiefly uſed at whiſt and piquet. The broad cards are uſually for kings, queens, knaves, and aces; the long for the reſt. Their deſign is to direct the cuttings, to enable him in the ſecret to cut the cards diſadvantageouſly to his adverſary, and draw the perſon unacquainted with the fraud to cut them favourably for the ſharper. As the pack is placed either endwiſe or ſidewiſe to him that is to cut, the long or broad cards naturally lead him to cut them. Breef cards are ſometimes made thus by the manufacturer; but, in defect of theſe, ſharpers pare all but the breefs with a penknife or razor. 3. *Corner bend*, denotes four cards turned down finely at one corner, to ſerve as a ſignal to cut by. 4. *Middle bend*, or Kingſton-bridge, is where the tricks are bent two different ways, which cauſes an opening or arch in the middle, to direct likewiſe the cutting.

Cards were invented about the year 1390, to divert Charles VI. of France, who had fallen into a melancholy diſpoſition. The inventor propoſed, by the figures of the four ſuits or colours, as the French call them, to repreſent the four claſſes of men in the kingdom. By the *cœurs* (hearts) are meant the *gens de choeur*, choir-men, or eccleſiaſtics; and therefore the Spaniards, who certainly received the uſe of cards from the French, have *copas*, or chalices, inſtead of hearts. The nobility, or prime military part of the kingdom, are repreſented by the ends or points of lances or pikes; and our ignorance of the meaning or the reſemblance of the figure induced us to call them *ſpades*: The Spaniards have *eſpadas*, ſwords, in lieu of pikes, which are of ſimilar import. By diamonds are deſigned the order of citizens, merchants, or tradeſmen, *carreaux*, (ſquare ſtones, tiles, or the like): The Spaniards have a coin, *dineros*, which anſwers to it: and the Dutch call the French word *carreaux* "*ſtreneen*," ſtones and diamonds, from the form. *Trefle*, the trefoil-liſe, or clover-graſs (corruptly called *clubs*), alludes to the huſbandmen and peaſants. But how this ſuit came to be called *clubs* is not eaſily explained; unleſs borrowing the game from the Spaniards, who have *baſtos* (ſtaves or clubs) inſtead of the trefoil, we give the Spaniſh ſignification to the French figure.

The hiſtory of the four kings, which the French, in drollery, ſometimes call the *cards*, are David, Alexander, Cæſar, and Charles; which names were then, and ſtill are on the French cards. Theſe reſpectable names repreſent the four celebrated monarchies of the Jews, Greeks, Romans, and Franks under Charlemagne. By the queens are intended Argine, Eſther, Judith, and Pallas (names retained in the French cards), typical of birth, piety, fortitude, and wiſdom, the qualifications reſiding in each perſon. *Argine* is an anagram for *regina*, queen by deſcent. By the knaves were deſigned the ſervants to knights (for *knave* originally meant only *ſervant*); but French pages and valets, now indiſcriminately uſed by various orders of perſons, were formerly only allowed to perſons of quality, eſquires (*eſcuires*), ſhield or armour bearers. Others fancy that the knights themſelves were deſigned by thoſe cards; becauſe Hogier and Lahire, two names on the French cards, were famous knights at the time cards were ſuppoſed to have been invented.

Deceptions with CARDS. See LEGERDEMAIN, ſect. i.

CARDAMINE, in *Botany*: A genus of the ſiliquoſa order, belonging to the tetradynamia claſs of plants; and in the natural method ranking under the 39th order *Siliquoſæ*. The ſiliqua parts aſunder with a ſpring, and the valves roll ſpirally backward; the ſtigma is entire, and the calyx a little gaping. Of this there are 15 ſpecies; but the moſt remarkable is the pratenſis, with a large purpliſh flower. This grows naturally in many parts of Britain, and is alſo called *cuckow flower*. There are four varieties, viz. the ſingle, with purple and white flowers, which are frequently intermixed in the meadows; and the double, of both colours. The ſingle ſorts are not admitted into gardens; but the double deſerve a place, as making a pretty appearance during the time they are in flower. They will thrive in a moiſt ſhady border; and are propagated by parting their roots, which is beſt performed in autumn. They delight in a ſoft loamy ſoil, not too ſtiff. By ſome the plant is reckoned antiſcorbutic.

CARDAMOM, in the *Materia Medica*. See AMOMUM.

CARDAN, JEROM, one of the moſt extraordinary geniuſes of his age, was born at Pavia on the 24th of September 1501. As his mother was not married, ſhe tried every method to procure an abortion, but without effect. She was three days in labour, and they were at laſt obliged to cut the child from her. He was born with his head covered with black curled hair. When he was four years old, he was carried to Milan; his father being an advocate in that city. At the age of 20, he went to ſtudy at the univerſity of that city; and two years afterwards he explained Euclid. In 1524, he went to Padua; and the ſame year he was admitted to the degree of maſter of arts: in the end of the following year, he took the degree of doctor of phyſic. He married about the year 1531. For ten years before, his impotency had hindered him from having knowledge of a woman; which was a great mortification to him. He attributed it to the evil influences of his planet under which he was born. When he enumerates, as he frequently does, the greateſt misfortunes of his life, this ten years impotency is always one. At the age of 32, he became profeſſor of mathematics at Milan. In 1539, he was admitted member of the college of phyſicians at Milan; in 1543, he read public lectures of medicine in that city, and at Pavia the year following; but diſcontinued them becauſe he could not get payment of his ſalary, and returned to Milan. In 1552, he went into Scotland, having been ſent for by the archbiſhop of St Andrew's, who had in vain applied to the French king's phyſicians, and afterwards to thoſe of the emperor of Germany. This prelate, then 40 years old, had for ten years been afflicted with a ſhortneſs of breath, which returned every eight days for the laſt two years. He began to recover from the moment that Cardan preſcribed for him. Cardan took his leave of him at the end of ſix weeks and three days, leaving him preſcriptions which in two years wrought a complete cure.

Cardan's journey to Scotland gave him an opportunity of viſiting ſeveral countries. He croſſed France in going thither; and returned through Germany, and the Low Countries, along the banks of the Rhine. It was on this occaſion he went to London, and calculated King Edward's nativity. This tour took up about four months: after which, coming back to Milan, he continued there till the beginning of October 1552; and then went to Pavia, from whence he was invited to Bologna in 1562. He taught in this laſt city till the year 1570; at which time he was thrown into priſon; but ſome months after he was ſent home to his own houſe. He left Bologna in 1571; and went to Rome, where he lived for ſome time without any public employment. He was however, admitted a member of the college of phyſicians, and received a penſion from the pope. He died at Rome on the 21ſt of September 1575, according to Thuanus. This account might be ſufficient to ſhow the reader that Cardan was of a very fickle temper; but he will have a much better idea of his ſingular and odd turn of mind by examining what he himſelf has written concerning his own good and bad qualities. He paid himſelf congratulatory compliments for not having a friend in this world; but that in requittal, he was attended by an aerial ſpirit, emaned partly from Saturn and partly from Mercury, who was the conſtant guide of his actions, and teacher of every duty to which he was bound. He declared, too, that he was ſo irregular in his manner of walking the ſtreets, as induced all beholders to point at him as a fool. Sometimes he walked very ſlowly, like a man abſorbed in profound meditation; then all on a ſudden quickened his ſteps, accompanying them with very abſurd attitudes. In Bologna his delight was to be drawn about in a mean vehicle with three wheels. When nature did not viſit him with any pain, he would procure to himſelf that diſagreeable ſenſation by biting his lips ſo wantonly, or pulling his fingers to ſuch a vehement degree, as ſometimes to force the tears from his eyes: and the reaſon he aſſigned for ſo doing, was to moderate certain impetuous ſallies of the mind, the violence of which was to him by far more inſupportable than pain itſelf; and that the ſure conſequence of ſuch a ſevere diſcipline was the enjoying the pleaſure of health. He ſays elſewhere, that, in the greateſt tortures of ſoul, he uſed to whip his legs with rods, and bit his left arm; that it was a great relief to him to weep, but that very often he could not; that nothing gave him more pleaſure than to talk of things which made the whole company uneaſy; that he ſpoke on all ſubjects, in ſeaſon and out of ſeaſon; and he was ſo fond of games of chance, as to ſpend whole days in them, to the great prejudice of his family and reputation, for he even ſtaked his furniture and his wife's jewels.

Cardanus makes no ſcruple of owning that he was revengeful, envious, treacherous, a dealer in the black-art, a backbiter, a calumniator, and addicted to all the foul and deteſtable exceſſes that can be imagined: yet notwithſtanding (as one would think) ſo humbling a declaration, there was never perhaps a vainer mortal, or one that with leſs ceremony expreſſed the high opinion he had of himſelf, than Cardanus was known to do, as will appear by the following proofs, "I have been admired by many nations: an infinite number of panegyrics, both in proſe and verſe, have been compoſed to celebrate my fame. I was born to releaſe the world from the manifold errors under which it groaned. What I have found out could not be diſcovered either by my predeceſſors or my cotemporaries; and that is the reaſon why thoſe authors who write any thing worthy of being remembered, ſcruple not to own that they are indebted to me for it. I have compoſed a book on the dialectic art, in which there is neither one ſuperfluous letter nor one deficient. I finiſhed it in ſeven days, which ſeems a prodigy. Yet where is there a perſon to be found, that can boaſt of his having become maſter of its doctrine in a year? And he that ſhall have comprehended it in that time, muſt appear to have been inſtructed by a familiar dæmon."

The ſame capriciouſneſs obſervable in his outward conduct is to be obſerved in the compoſition of his works. We have a multitude of his treatiſes in which the reader is ſtopped almoſt every moment by the obſcurity of his text, or his degreſſions from the point in hand. In his arithmetical performances there are ſeveral diſcourſes on the motions of the planets, on the creation, and on the tower of Babel. In his dialectic work, we find his judgment on the hiſtorians and the writers of epiſtles. The only apology which he makes for the frequency of his digreſſions is, that they were purpoſely done for the ſooner filling up of his ſheet, his bargain with the bookſeller being at ſo much per ſheet: and that he worked as much for his daily ſupport as for the acquiſition of glory. The Lyons edition of his works, printed in 1663, conſiſts of ten volumes in folio.

It was Cardanus who revived in latter times all the ſecret philoſophy of the Cabbala or Cabbaliſts, which filled the world with ſpirits; a likeneſs to whom, he aſſerted, we might attain by purifying ourſelves with philoſophy. He choſe for himſelf, however, notwithſtanding ſuch reveries, this fine device, *Tempus mea poſſeſſio, tempus meus ager*: "Time is my ſole poſſeſſion, and the only fund I have to improve."

In fact, when we conſider the tranſcendent qualities of Cardan's mind, we cannot deny his having cultivated it with every ſpecies of knowledge, and his having made a greater progreſs in philoſophy, in the medical art, in aſtronomy, in mathematics, &c. than the greateſt part of his cotemporaries who had applied their minds but to one of thoſe ſciences.

Scaliger affirms, that Cardan, having fixed the time of his death, abſtained from food, that this prediction might be fulfilled, and that his continuance to live might not diſcredit his art. Cardan's father, who was a doctor of medicine, and a profeſſor of civil and canon law, died in the ſame manner in the year 1524, having abſtained from all ſuſtenance for nine days. His ſon tells us that he had white eyes, and could ſee in the night time.

CARDASS, a ſort of card proper for carding flocks of ſilk, to make cappadine of it. It is alſo the name which the French give to thoſe flocks of ſilk.

CARDASSES, is alſo the name which, in the cloth manufactories of Languedoc, they give to a ſort of large card, which is uſed for carding the dyed wool, deſigned for making cloth of mixed colours.

CARDERS, in the woollen manufactory, are perſons who prepare wool, &c. for ſpinning, &c.

Carders, ſpinners, weavers, fullers, ſheerman, and dyers, not performing their duty in their occupations, ſhall yield to the party grieved double damages; to be committed until payment. One juſtice to hear and determine complaints.

Carders, combers, ſorters, ſpinners, or weavers, conveying away, embezzling, or detaining, any wool or yarn, delivered by the clothier, or any other perſon, ſhall give the party grieved ſuch ſatisfaction as two juſtices, mayor, &c. ſhall think fit: if not able or willing to make ſatisfaction, for the firſt offence to be whipped, or ſet in the ſtocks in ſome market-town, or in any other town where the offence is committed: the ſecond offence to incur the like, or ſuch further puniſhment by whipping, &c. as juſtices ſhall think proper. Conviction by one witneſs on oath, or confeſſion.

CARDI, Ludovico. See Civoli.

CARDIAC, in a general ſenſe, ſignifies all medicines beneficial to the heart, whether internally or externally applied. The word comes from the Greek word καρδία, *cor;* the heart being reputed the immediate ſeat of their operation.

Cardiacs, in a more particular ſenſe, denote medicines which raiſe the ſpirits and give preſent ſtrength and cheerfulneſs; theſe amount to the ſame with what are properly called *cordials*. Cardiacs are medicines anciently ſuppoſed to exert themſelves immediatly in comforting and ſtrengthening the heart: but the modern phyſicians rather ſuppoſe them to produce the effect by putting the blood into a gentle fermentation, whereby the ſprings, before decayed, are repaired and invigorated, and the tone and elaſticity of the fibres of the veſſels reſtored; the conſequence of which is a more eaſy and briſk circulation.

CARDIALGIA, in *Medicine*, a violent ſenſation of heat or acrimony felt towards the upper or left orifice of the ſtomach, though ſeemingly at the heart; ſometimes accompanied with palpitations of the heart, fainting, and a propenſity to vomit: better known by the name of *cardiac paſſion*, or *heart-burn*. See Medicine *Index*.

CARDIFF, a town of Glamorganſhire, in South Wales, ſeated on the river Tave, in a rich and fruitful ſoil. It is a large, compact, well built town, having a caſtle, a wall, and four gates, built by Robert Fitz-Hamon, a Norman, about the year 1100. It is governed by the conſtable of the caſtle, 12 aldermen, 12 burgeſſes, &c. and ſends one member to parliament. Here the aſſizes and ſeſſions are held, beſides ſeveral courts. There is a handſome bridge over the river, to which ſmall veſſels come to take in their lading. It has now only one church; St Mary's having been long ſince thrown down by the undermining of the river. The caſtle, though much decayed, makes a grand appearance even at this time; and the walls of the town are very ſtrong and thick. The church has a fine tower-ſteeple, and the town-hall is a good ſtructure. The magiſtrates are elected every year by the majority of the burgeſſes. W. Long. 3. 20. N. Lat. 51. 30. Cardiff gives title of Britiſh Baron to the family of Bute in Scotland.

CARDIGAN, the capital town of Cardiganſhire, in South Wales, is ſeated near the mouth of the river Teivy, on the Iriſh channel. It is indifferently large and well built, containing three wards, one church, and the county-gaol. It is governed by a mayor, 13 aldermen, 13 common-council men, &c. Here are the ruins of a caſtle which was built by Gilbert de Clare, about the year 1160. It ſends one member to parliament; and has two markets held on Tueſdays and Saturdays. W. Long. 4. 38. N. Lat. 52. 15.

CARDIGANSHIRE, a county of South Wales, bounded on the north by Merionethſhire and Montgomeryſhire, on the eaſt by Radnorſhire and Brecknockſhire, on the weſt by the Iriſh ſea, and on the ſouth by Caermarthenſhire. Its length from north-weſt to ſouth-eaſt is about 44 miles, and its breadth near 20. The air, as in other parts of Wales, varies with the ſoil, which in the ſouthern and weſtern parts is more upon a level than this principality generally is, which renders the air mild and temperate. But as the northern and eaſtern parts are mountainous, they are conſequently more barren and bleak. However, there are cattle bred in all parts; but they have neither wood nor coals of their own for fuel: they have rich lead mines, and fiſh in plenty, with fowls both tame and wild. The principal rivers are the Teivy, the Ridol, and the Iſtwith. This county hath five market-towns, viz. Cardigan, Aberiſtwith, Llanbadarnvawn, Llanbedar, and Tregaron, with 77 pariſhes; and was formerly computed to have upwards of 3000 houſes, and 520,000 acres of land. It ſends two members to parliament; one for the county, and one for Cardigan.

CARDINAL, in a general ſenſe, an appellation given to things on account of their pre-eminence. The word is formed of the Latin *cardo, a hinge;* it being on theſe fundamental points that all the reſt of the ſame kind are ſuppoſed to turn. Thus, juſtice, prudence, temperance, and fortitude, are called the four *cardinal virtues*, as being the baſis of all the reſt.

Cardinal *Flower*. See Lobelia, Botany *Index*.

Cardinal *Points*, in *Coſmography*, are the four interſections of the horizon with the meridian, and the prime vertical circle. Of theſe, two, viz. the interſections of the horizon and meridian, are called *North* and *South*, with regard to the poles they are directed to. The other two, viz. the interſections of the horizon and firſt vertical, are called *Eaſt* and *Weſt*.

The cardinal points, therefore, coincide with the four cardinal regions of the heavens; and are 90° diſtant from each other. The intermediate points are called *collateral points*.

Cardinal *Points*, in *Aſtrology*, are the riſing and ſetting of the ſun, the zenith, and nadir.

Cardinal *Signs*, in *Aſtronomy*, are Aries, Libra, Cancer, and Capricorn.

Cardinal *Winds* are thoſe that blow from the cardinal points.

Cardinal *Numbers*, in *Grammar*, are the numbers one, two, three, &c. which are indeclinable; in oppoſition to the ordinal numbers, firſt, ſecond, third, fourth, &c.

Cardinal, an eccleſiaſtical prince in the Romiſh church, being one who has a voice in the conclave at the election of a pope. Some ſay the cardinals were ſo called from the Latin *incardinatio*, which ſignifies the adoption in any church made of a prieſt of a foreign church, driven thence by misfortune; and add, that the uſe of the word commenced at Rome and Ravenna; the revenues of the churches of which cities being very great, they became the common refuge of the unhappy prieſts of all other churches.

The cardinals compoſe the pope's council or ſenate: in the Vatican is a conſtitution of Pope John, which regulates the rights and titles of the *cardinals;* and which declares, that as the pope repreſents Moſes, ſo the cardinals repreſent the ſeventy elders, who, under the pontifical authority, decide private and particular differences.

Cardinals, in their firſt inſtitution, were only the principal prieſts, or incumbents of the pariſhes of Rome. In the primitive church, the chief prieſt of a pariſh, who immediately followed the biſhop, was called *presbyter cardinal*, to diſtinguiſh him from the other petty prieſts, who had no church nor preferment; the term was firſt applied to them in the year 150; others ſay, under Pope Silveſter, in the year 300. Theſe cardinal prieſts were alone allowed to baptize, and adminiſter the euchariſt. When the cardinal prieſts became biſhops, their cardinalate became vacant; they being then ſuppoſed to be raiſed to a higher dignity.—Under Pope Gregory, cardinal prieſts, and cardinal deacons, were only ſuch prieſts and deacons as had a church or chapel under their particular care: and this was the original uſe of the word. Leo IV. in the council of Rome, held in 853, calls them *presbyteros sui cardinis;* and their churches, *parochias cardinales.*

The cardinals continued on this footing till the eleventh century: but as the grandeur and ſtate of his holineſs became then exceedingly augmented, he would have his council of cardinals make a better figure than the ancient prieſts had done. It is true, they ſtill preſerved their ancient title; but the thing expreſſed by it was no more. It was good while, however, before they had the precedence over the biſhops, or got the election of the pope into their hands: but when they were once poſſeſſed of thoſe privileges, they ſoon had the red hat and purple; and growing ſtill in authority, they became at length ſuperior to the biſhops, by the ſole quality of being cardinals.

Du Cange obſerves, that originally there were three kinds of churches: the firſt or genuine churches were properly called *pariſhes;* the ſecond *deaconries*, which were chapels joined to hoſpitals, and ſerved by deacons; the third were ſimple *oratories*, where private maſſes were ſaid, and were diſcharged by local and reſident chaplains. He adds, that to diſtinguiſh the principal or pariſh churches from the chapels and oratories, the name *cardinales* was given to them. Accordingly, pariſh churches gave titles to cardinal prieſts: and ſome chapels alſo, at length, gave the title of *cardinal deacons*.

Others obſerve, that the term *cardinal* was given not only to prieſts, but alſo to biſhops and deacons who were attached to certain churches, to diſtinguiſh them from thoſe who only ſerved them *en passant*, and by commiſſion. Titular churches, or benefices, were a kind of pariſhes, i. e. churches, aſſigned each to a cardinal prieſt; with ſome ſtated diſtrict depending on it, and a font for adminiſtering of baptiſm, in caſes where the biſhop himſelf could not adminiſter it. Theſe cardinals were ſubordinate to the biſhops; and accordingly, in councils, particularly that held at Rome in 868, ſubſcribed after them.

It was not, however, only at Rome, that prieſts bore this name; for we find there were cardinal prieſts in France: thus, the curate of the pariſh of St John de Vignes is called in old charters the *cardinal prieſt* of that pariſh.

The title of *cardinal* is alſo given to ſome biſhops, *quatenus* biſhops; e. g. to thoſe of Mentz and Milan: the archbiſhops of Bourges is alſo, in ancient writings, called *cardinal;* and the church of Bourges, a *cardinal church.* The abbot of Vendome calls himſelf *cardinalis natus.*

The cardinals are divided into three claſſes or orders; containing ſix biſhops, fifty prieſts, and fourteen deacons; making in all ſeventy: which conſtitute what they call the *ſacred college.* The cardinal biſhops, who are, as it were, the pope's vicars, bear the titles of the biſhopricks aſſigned to them; the reſt take ſuch titles as are given them: the number of cardinal biſhops has been fixed; but that of cardinal prieſts and deacons, and conſequently the ſacred college itſelf, is always fluctuating. Till the year 1125, the college only conſiſted of fifty-two or fifty-three: the council of Conſtance reduced them to twenty-four; but Sixtus IV. without any regard to that reſtriction, raiſed them again to fifty-three, and Leo to ſixty-five. Thus, as the number of cardinal prieſts was anciently fixed to twenty-eight, new titles were to be eſtabliſhed, in proportion as new cardinals were created. As for the cardinal deacons, they were originally no more than ſeven for the fourteen quarters of Rome; but they were afterwards increaſed to nineteen, and after that were again diminiſhed.

According to Onuphrius, it was Pope Pius IV. who firſt enacted, in 1562, that the pope ſhould be choſen only by the ſenate of cardinals; whereas, till that time, the election was by all the clergy of Rome. Some ſay, the election of the pope reſted in the cardinals, excluſive to the clergy, in the time of Alexander III. in 1160. Others go higher ſtill, and ſay, that Nicholas II. having been elected at Sienna, in 1058, by the cardinals alone, occaſioned the right of election to be taken from the clergy and people of Rome; only leaving them that of confirming him by their conſent; which was at length, however, taken from them. See his decree for this purpoſe, iſſued in the Roman council of 1059, in Hardouin's Acta Conciliorum, tom. vi. pt. i. p. 1165. Whence it appears, that the cardinals who had the right of ſuffrage in the election of his ſucceſſors, were divided by this pontiff into *cardinal biſhops* and *cardinal clerks:* meaning by the former the ſeven biſhops who belonged to the city and territory of Rome; and by the latter, the *cardinal presbyters*, or miniſters of the twenty-eight Roman pariſhes, or principal churches. To theſe were added, in proceſs of time, under Alexander III. and other pontiffs, new members, in order to appeaſe the tumults occaſioned by the edict of Nicholas II.

At the creation of a new cardinal, the pope performs the ceremony of opening and ſhutting his mouth; which is done in a private conſiſtory. The ſhutting his mouth implies the depriving him of the liberty of giving his opinion in congregations; and the opening his mouth, which is performed 15 days after, ſignifies the taking off his reſtraint. However, if the pope happens to die during the time a cardinal's mouth is ſhut, he can neither give his voice in the election of a new pope, nor be himſelf advanced to that dignity.

The dreſs of a cardinal is a red ſoutanne, a rocket, a ſhort purple mantle, and a red hat.

The cardinals began to wear the red hat at the council of Lyons, in 1243. The decree of Pope Urban VIII. whereby it is appointed that the cardinals be addreſſed under the title of *eminence*, is of the year 1630; till then, they were called *illuſtriſſimi*.

When cardinals are ſent to the courts of princes, it is in quality of legates *a latere*; and when they are appointed governors of towns, their government is called by the name of *legation*.

CARDINAL has alſo been applied to ſecular officers, Thus, the prime miniſters in the court of the emperor Theodoſius, are called *cardinales*. Caſſiodorus, lib. vii. formul. 31. makes mention of the cardinal-prince of the city of Rome; and in the liſt of officers of the duke of Bretagne, in 1447, we meet with one Raoul de Thorel, cardinal of Quillart, chancellor, and ſervant of the viſcount de Rohan: which ſhows it to have been an inferior quality.

CARDIOID, in the higher geometry, an algebraical curve, ſo called from its reſemblance to a heart.

CARDIOSPERMUM. See BOTANY *Index*.

CARDIUM, or COCKLE, in *Zoology*, a genus of inſects belonging to the order of *vermes teſtacea*. The ſhell conſiſts of two equal valves, and the ſides are equal. There are 21 ſpecies of this genus. Common on all ſandy coaſts, lodged a little beneath the ſand; their place is marked by a depreſſed ſpot. They are wholeſome and delicious food.

CARDONA, a handſome town of Spain, in Catalonia, with a ſtrong caſtle, and the title of a dutchy. Near it is an inexhauſtible mountain of ſalt of ſeveral colours, as red, white, carnation, and green: but when waſhed, it becomes white. There are alſo vineyards which produce excellent wine, and very lofty pinetrees. It is ſeated on an eminence, near the river Cardenero. E. Long. 1. 26. N. Lat. 41. 42.

CARDUUS. See BOTANY *Index*.

CARDUUS *Benedictus*, *Bleſſed thiſtle*. See CNICUS, BOTANY *Index*.

CAREENING, in the ſea-language, the bringing a ſhip to lie down on one ſide, in order to trim and caulk the other ſide.

A ſhip is ſaid to be brought to the careen, when, the moſt of her lading being taken out, ſhe is hulled down on one ſide, by a ſmall veſſel, as low as neceſſary; and there kept by the weight of the balaſt, ordnance, &c. as well as by ropes, leſt her maſts ſhould be ſtrained too much; in order that her ſides and bottom may be trimmed, ſeams caulked, or any thing that is faulty under water mended. Hence, when a ſhip lies on one ſide when ſhe ſails, ſhe is ſaid to ſail on the careen.

CAREER in the *Manege*, a place incloſed with a barrier, wherein they run the ring.

The word is alſo uſed for the race or courſe of the horſe itſelf, provided it do not exceed 200 paces.

In the ancient circus, the career was the ſpace the bigæ, or quadrigæ, were to run at full ſpeed, to gain the prize. See CIRCUS.

CAREER, in *Falconry*, is a flight or tour of the bird, about 120 yards. If ſhe mount more, it is called a *double career*; if leſs, a *ſemi-career*

CARELIA, the eaſtern province of Findland; divided into Swediſh Carelia, and Muſcovite Carelia. The capital of the latter is Povenza, and of the former Weiburg.

CARELSCROON, a ſea-port town of Sweden, in Bleckingia, or Bleking, on the Baltic ſea, with a very good harbour defended by two forts. It was built in 1679; and is very populous, with arſenals for the marine: the houſe of the director-general of the admiralty is in this town, and here the Swedes lay up their royal navy. E. Long. 15. 5. N. Lat. 56. 15.

CARENTAN, a town of France in Lower Normandy, and in the Contentin, with an ancient caſtle. W. Long. 1. 14. N. Lat. 49. 20.

CARET, among grammarians, a character marked thus ʌ, ſignifying that ſomething is added on the margin, or interlined, which ought to come in where the caret ſtands.

CAREW, GEORGE, born in Devonſhire in 1557, an eminent commander in Ireland, was made preſident of Munſter by Queen Elizabeth; when, joining his forces with the earl of Thomond, he reduced the Iriſh inſurgents, and brought the earl of Deſmond to his trial. King James made him governor of Guernſey, and created him a baron. As he was a valiant commander, he was no leſs a polite ſcholar; and wrote *Paccata Hibernia*, a hiſtory of the late wars in Ireland, printed after his death, in 1633. He made ſeveral collections for a hiſtory of Henry V. which are digeſted into Speed's Hiſtory of Great Britain. Beſides theſe, he collected materials of Iriſh hiſtory in four large MMS. volumes, now in the Bodeleian library, Oxford.

CAREW, *Thomas*, deſcended from the family of Carew in Glouceſterſhire, was gentleman of the privy chamber to Charles I. who always eſteemed him one of the moſt celebrated wits of his court. He was much reſpected by the poets of his time, particularly by Ben Johnſon and Sir William Davenant; and left behind him ſeveral poems, and a maſque called *Cœlum Britannicum*, performed at Whitehall on Shrove Tueſday night, 1633, by the king, and ſeveral of his nobles with their ſons. Carew was aſſiſted in the contrivance by Inigo Jones, and the muſic was ſet by Mr Henry Lawes of the king's chapel. He died in the prime of life, about the year 1639.

CAREW, *Richard*, author of the "Survey of Cornwall," was the eldeſt ſon of Thomas Carew of Eaſt Anthony, and was born in 1555. When very young, he became a gentleman commoner of Chriſt-church college, Oxford; and at 14 years of age had the honour of diſputing, extempore, with the afterwards famous Sir Philip Sydney, in the preſence of the earls of Leiceſter, Warwick, and other nobility. After ſpending three years at the univerſity, he removed to the Middle Temple, where he reſided the ſame length of time, and then travelled into foreign parts. Not long after his return to England, he married, in 1577, Juliana Arundel, of Trerice. In 1581, Mr Carew was made juſtice of the peace, and in 1586 was appointed high-ſheriff of the county of Cornwall; about which time he was likewiſe queen's deputy for the militia.

Carew.

In 1589, he was elected a member of the college of Antiquaries, a diſtinction to which he was entitled by his literary abilities and purſuits. What particularly engaged his attention with his native country, his "Survey" of which was publiſhed, in 4to, at London, in 1602. It has been twice reprinted, firſt in 1723, and next in 1769. Of this work Camden hath ſpoken in high terms, and acknowledges his obligations to the author. In the preſent improved ſtate of topographical knowledge, and ſince Dr Borlaſe's excellent publications relative to the county of Cornwall, the value of Carew's "Survey" muſt have been greatly diminiſhed. Mr Gough remarks, that the hiſtory and monuments of this country were faintly touched by Carew; but it is added, that he was a perſon extremely capable of deſcribing them, if the infancy of thoſe ſtudies at that time had afforded light and materials. Another work of our author was a tranſlation from the Italian, entitled, "The examination of Men's Wits. In which, by diſcovering the variety of natures, is ſhowed for what profeſſion each one is apt, and how far he ſhall profit therein." This was publiſhed at London in 1594, and afterwards in 1604; and though Richard Carew's name is prefixed to it, hath been principally aſcribed by ſome perſons to his father. According to Wood, Carew wrote alſo, "The true and ready Way to learn the Latin Tongue," in anſwer to a query, whether the ordinary method of teaching the Latin by the rules of grammer be the beſt mode of inſtructing youths in that language? This tract is involved in Mr Hartlib's book upon the ſame ſubject, and with the ſame title. It is certain that Carew was a gentleman of conſiderable abilities and literature, and that he was held in great eſtimation by ſome of the moſt eminent ſcholars of his time. He was particularly intimate with Sir Henry Spelman, who extols him for his ingenuity, virtue, and learning.

CAREW, *George*, brother to the ſubject of the laſt article, was educated in the univerſity of Oxford, after which he ſtudied the law in the inns of Court, and then travelled into foreign countries for farther improvement. On his return to his native country, he was called to the bar, and after ſome time was appointed ſecretary to Sir Chriſtopher Hatton, lord chancellor of England. This was by the ſpecial recommendation of Queen Elizabeth herſelf, who gave him a prothonotaryſhip in the chancery, and conferred upon him the honour of knighthood. In 1597, Sir George Carew, who was then a maſter in chancery, was ſent ambaſſador to the king of Poland. In the next reign, he was one of the commiſſioners for treating with the Scotch concerning an union between the two kingdoms; after which he was appointed ambaſſador to the court of France, where he continued from the latter end of the year 1605 till 1609. During his reſidence in that country, he formed an intimacy with Thuanus, to whom he communicated an account of the tranſactions in Poland whilſt he was employed there, which was of great ſervice to that admirable author in drawing up the 121ſt book of his hiſtory. After Sir George Carew's return from France, he was advanced to the important poſt of maſter of the court of wards, which honourable ſituation he did not long live to enjoy; for it appears, from a letter written by Thuanus to Camden in the ſpring 1613, that he was then lately deceaſed. Sir George Carew married Thomaſine, daughter of Sir Francis Godolphin, great grandfather of the lord treaſurer Godolphin, and had by her two ſons and three daughters. When Sir George Carew returned, in 1609, from his French ambaſſy, he drew up, and addreſſed to James I. "A Relation of the State of France, with the characters of Henry IV. and the principal perſons of that Court." The characters are drawn from perſonal knowledge and cloſe obſervation, and might be of ſervice to a general hiſtorian of that period. The compoſition is perſpicuous and manly, and entirely free from the pedantry which prevailed in the reign of James I. but this is the leſs ſupriſing, as Sir George Carew's taſte had been formed in a better æra, that of Queen Elizabeth. The valuable tract we are ſpeaking of lay for a long time in MS. till happily falling into the hands of the Earl of Hardwicke, it was communicated by him to Dr Birch, who publiſhed it, in 1749, at the end of his "Hiſtorical View of the Negotiations between the Courts of England, France, and Bruſſels, from 1592 to 1617." That intelligent and induſtrious writer juſtly obſerves, that it is a model upon which ambaſſadors may form and digeſt their notions and repreſentations; and the late celebrated poet Mr Gray hath ſpoken of it as an excellent performance.

Carex.
Carey.

CAREX, SEDGE-GRASS. See BOTANY *Index*.

CAREY, HARRY, a man diſtinguiſhed by both poetry and muſic, but perhaps more ſo by a certain facetiouſneſs, which made him agreeable to every body. He publiſhed in 1720 a little collection of poems; and in 1732, ſix cantatas, written and compoſed by himſelf. He alſo compoſed ſundry ſongs for modern comedies, particularly thoſe in the "Provoked Huſband:" he wrote a farce called "The Contrivances," in which were ſeveral little ſongs to very pretty airs of his own compoſition: he alſo made two or three little dramas for Goodman's-fields theatre, which were very favourably received. In 1729, he publiſhed by ſubſcription his poems much enlarged: with the addition of one entitled "Namby Pamby," in which Ambroſe Philips is ridiculed. Carey's talent, ſays his hiſtorian, lay in humour and unmalevolent ſatire: to ridicule the rant and bombaſt of modern tragedies he wrote one, to which he gave the ſtrange title of "Chrononhotonthologos," acted in 1734. He alſo wrote a farce called "The Honeſt Yorkſhireman." Carey was a thorough Engliſhman, and had an unſurmountable averſion to the Italian opera and the ſingers in it: he wrote a burleſque opera on the ſubject of the "Dragon of Wantley; and afterwards a ſequel to it, entitled, "The Dragoneſs;" both which were eſteemed a true burleſque upon the Italian opera. His qualities being of the entertaining kind, he was led into more expences than his finances could bear, and thus was frequently in diſtreſs. His friends, however, were always ready to aſſiſt him by their little ſubſcriptions to his works: and encouraged by theſe, he republiſhed, in 1740, all the ſongs he had ever compoſed, in a collection, entitled, "The Muſical Century, in 100 Engliſh Ballads, &c." and, in 1743, his dramatic works, in a ſmall volume, 4to. With all his mirth and good humour, he ſeems to have been at times deeply affected with the malevolence of ſome of his own profeſſion, who, for reaſons that no one can gueſs at, were his enemies; and this, with the preſſure of his circumſtances, is ſuppoſed to have occaſioned his untimely end; for, about 1744, in a fit of deſperation, he laid violent hands on himſelf, and, at his houſe in Warner-ſtreet, Cold-bath Fields, put a period to a life, which, ſays Sir John Hawkins, had been led without reproach. It is to be noted, and it is ſomewhat ſingular in ſuch a character, that in all his ſongs and poems on wine, love, and ſuch kind of ſubjects, he ſeems to have manifeſted an inviolable regard for decency and good manners.

CARGADORS, a name which the Dutch give to thoſe brokers whoſe buſineſs is to find freight for ſhips outward bound, and to give notice to the merchants, who have commodities to ſend by ſea, of the ſhips that are ready to ſail, and of the places for which they are bound.

CARGAPOL, or KARGAPOL, the capital of a territory of the ſame name, in the province of Dwina, in Muſcovy. E. Long. 36°. N. Lat. 63°.

CARGO denotes all the merchandiſes and effects which are laden on board a ſhip.

Super-CARGO, a perſon employed by merchants to go a voyage, overſee the cargo, and diſpoſe of it to the beſt advantage.

CARIA, in *Ancient Geography*, a country of the Hither Aſia; whoſe limits are extended by ſome, while they are contracted by others. Mela and Pliny extend the maritime Caria from Jaſus and Halicarnaſſus, to Calynda, and the borders of Lycia. The inland Caria Ptolemy extends to the Meander and beyond. *Car*, *Cariates*, *Cariatis*, *Cariſſa*, and *Caris*, and *Caira*, are the gentilitious names; *Carius* and *Caricus* the epithets. *In Care periculum*, was a proverbial ſaying on a thing expoſed to danger, but of no great value. The *Cares* being the Swiſs of thoſe days, were hired and placed in the front of the battle, (Cicero.) *Cum Cane Cariſſa*, denoted the behaviour of clowns. The Cares came originally from the iſlands to the continent, being formerly ſubject to Minos, and called *Leleges*: this the Cretans affirm, and the Cares deny, making themſelves aborigines. They are of a common original with the Myſi and Lydi, having a common temple, of a very ancient ſtanding, at Melaſſa, a town of Caria, called *Jovis Carii Delubrum*, (Herodotus.) Homer calls the Carians, barbarians in language.

CARIATI, a town of Italy, in the kingdom of Naples, and province of Hither Calabria, with a biſhop's ſee, and the title of a principality. It is two miles from the gulf of Taranto, and 37 north-eaſt of Coſenza. E. Long. 17. 19. N. Lat. 30. 38.

CARIBBEE ISLANDS, a cluſter of iſlands ſituated in the Atlantic ocean between 59 and 63 degrees of weſt longitude, and between 11 and 18 degrees of north latitude. They lie in the form of a bow or ſemicircle, ſtretching almoſt from the coaſt of Florida north, to near the river Oroonoque. Thoſe that lie neareſt the eaſt have been called the *Windward Iſlands*, the others the *Leeward*, on account of the winds blowing generally from the eaſtern point in thoſe quarters. Abbe Raynal conjectures them to be the tops of very high mountains formerly belonging to the continent, which have been changed into iſlands by ſome revolution that has laid the flat country under water. The direction of the Caribbee iſlands, beginning from Tobago, is nearly north and N. N. W. The direction is continued, forming a line ſomewhat curved towards the north-weſt, and ending at Antigua. In this place the line becomes at once curved; and extending itſelf in a ſtraight direction to the weſt and north-weſt, meets in its courſe with Porto-Rico, St Domingo, and Cuba, known by the name of the *Leeward Iſlands*, which are ſeparated from each other by channels of various breadths. Some of theſe are 6, others 15 or 20 leagues broad; but in all of them the ſoundings are from 100 to 120 or 150 fathoms. Between Grenada and St Vincent's there is alſo a ſmall archipelago of 30 leagues, in which the ſoundings are not above ten fathoms. The mountains in the Caribbee iſlands run in the ſame direction as the iſlands themſelves. The direction is ſo regular, that if we were to conſider the tops of theſe mountains only, independent of their baſes, they might be looked upon as a chain of hills belonging to the continent, of which Martinico would be the moſt north-weſterly promontory. The ſprings of water which flow from the mountains in the Windward iſlands, run all in the weſtern parts of theſe iſlands. The whole eaſtern coaſt is without any running water. No ſprings come down there from the mountains: and indeed they would have there been uſeleſs; for after having run over a very ſhort tract of land, and with great rapidity, they would have fallen into the ſea. In Porto Rico, St Domingo, and Cuba, there are a few rivers that diſcharge themſelves on the northern ſide, and whoſe ſcurces riſe in the mountains running from eaſt to weſt, that is, through the whole length of theſe iſlands. From the other ſide of the mountains facing the ſouth, where the ſea, flowing with great impetuoſity, leaves behind it marks of its inundations, ſeveral rivers flow down, the mouths of which are capable of receiving the largeſt ſhips. The ſoil of the Caribbees conſiſts moſtly of a layer of clay or gravel of different thickneſs: under which is a bed of ſtone or rock. The nature of ſome of thoſe ſoils is better adapted to vegetables than others. In thoſe places where the clay is drier and more friable, and mixes with the leaves and remains of plants, a layer of earth is formed of greater depth than where the clay is moiſter. The ſand or gravel has different properties according to its peculiar nature; wherever it is leſs hard, leſs compact, and leſs porous, ſmall pieces ſeparate themſelves from it, which, though dry, preſerve a certain degree of coolneſs uſeful to vegetation. This ſoil is called in America a *pumice-ſtone* ſoil. Wherever the clay and gravel do not go through ſuch modifications, the ſoil becomes barren, as ſoon as the layer formed by the decompoſition of the original plants is deſtroyed.—By a treaty concluded in January 1660, between the French and Engliſh, the Caribs were confined to the iſlands of St Vincent's and Dominica, where all the ſcattered body of this people were united, and at that time did not exceed in number 6000 men. See ST. VINCENT'S and DOMINICA.

As the Caribbee iſlands are all between the tropics, their inhabitants are expoſed, allowing for the varieties reſulting from difference of ſituation and ſoil, to a perpetual heat, which generally increaſes from the riſing of the ſun till an hour after noon, and then declines in proportion as the ſun declines. The variations of the temperature of the air ſeem to depend rather on the wind than on the changes of the ſeaſons. In thoſe places where the wind does not blow, the air is exceſſively hot, and none but the eaſterly winds contribute to temper and refreſh it; thoſe that blow from the ſouth and weſt afford little relief: but they are much leſs frequent and leſs regular than that which blows from the eaſt. The branches of the trees expoſed to the influence of the latter are forced round towards the weſt: but their roots are ſtronger, and more extended under the ground, towards the eaſt than towards the weſt; and hence they are eaſily thrown down by ſtrong weſt winds or hurricanes from that quarter. The eaſterly wind is ſcarce felt in the Caribbee iſlands before nine or ten o'clock in the morning, increaſes in proportion as the ſun riſes above the horizon, and decreaſes as it declines. Towards the evening it ceaſes entirely to blow on the coaſts, but not on the open ſea. It has alſo been obſerved, that it blows with more force and more regularity in the dog-days than at any other time of the year.

The rain alſo contributes to the temperature of the Caribbee iſlands, though not equally in them all. In thoſe places where the eaſterly wind meets with nothing to oppoſe its progreſs, it diſpels the clouds as they begin to riſe, and cauſes them to break either in the woods or upon the mountains. But whenever the ſtorms are too violent, or the blowing of the eaſterly wind is interrupted by the changeable and temporary effect of the ſoutherly or weſterly ones, it then begins to rain. In the other Caribbee iſlands, where this wind does not generally blow, the rains are ſo frequent and plentiful, eſpecially in the winter ſeaſon, which laſts from the middle of July to the middle of October, that, according to the moſt accurate obſervations, as much rain falls in one week as in our climates in a year. Inſtead of thoſe mild refreſhing ſhowers which fall in the European climates, the rains of the Caribbee iſlands are torrents, the ſound of which might be miſtaken for hail, were not that almoſt totally unknown under ſo burning a ſky. Theſe ſhowers indeed refreſh the air; but they occaſion a dampneſs, the effects of which are not leſs diſagreeable than fatal. The dead muſt be interred within a few hours after they have expired. Meat will not keep ſweet above 24 hours. The fruits decay, whether they are gathered ripe or before their maturity. The bread muſt be made up into biſcuits, to prevent its growing mouldy. Common wines turn ſour, and iron turns ruſty, in a day's time. The ſeeds can only be preſerved by conſtant attention and care, till the proper ſeaſon returns for ſowing them. When the Caribbee iſlands were firſt diſcovered, the corn that was conveyed there for the ſupport of the Europeans, was ſo ſoon damaged that it became neceſſary to ſend it out in the ears. This neceſſary precaution ſo much enhanced the price of it, that few were able to purchaſe it. Flour was then ſubſtituted in lieu of corn; which lowered indeed the expences of tranſport, but had this inconvenience, that it was ſooner damaged. It was imagined by a merchant, that if the flour were entirely ſeparated from the bran, it would have the double advantage of being cheaper and keeping longer. He cauſed it therefore to be ſifted, and put the fineſt flour into ſtrong caſks, and beat it cloſe together with iron hammers, till it became ſo cloſe a body that the air could ſcarcely penetrate it. This method was found to anſwer the purpoſe; and if, by it, the flour cannot be preſerved as long as in our dry and temperate climates, it may be kept for ſix months, a year, or longer, according to the degree of care taken in the preparation.

However troubleſome theſe effects of the rain may be, it is attended with ſome others ſtill more formidable; namely, frequent and dreadful earthquakes.—Theſe happening generally during the time or towards the end of the rainy ſeaſon, and when the tides are higheſt, ſome ingenious naturaliſts have ſuppoſed that there might be a connexion between them. The waters of the ſky and of the ſea undermine, dig up, and ravage the earth in ſeveral different ways. Among the various ſhocks to which the Caribbee iſlands are expoſed from the fury of the boiſterous ocean, there is one diſtinguiſhed by the name of *raz de maree*, or *whirlpool*. It conſtantly happens once, twice, or thrice, from July to October, and always on the weſtern coaſts, becauſe it takes place after the time of the weſterly or ſoutherly winds, or while they blow. The waves, which at a diſtance ſeem to advance gently within 400 or 500 yards, ſuddenly ſwell againſt the ſhore, as if acted upon in an oblique direction, by ſome ſuperior force, and break with the greateſt impetuoſity. The ſhips which are then upon the coaſt, or in the roads beyond it, unable either to keep their anchors or to put out to ſea, are daſhed to pieces againſt the land, and all on board moſt commonly periſh. The hurricane is another terrible phenomenon in theſe iſlands, by which incredible damage is occaſioned; but happily it occurs not often.

The produce of the Caribbee iſlands is exceedingly valuable to the Europeans, conſiſting of ſugar, rum, molaſſes, indigo, &c. a particular account of which is given under the names of the reſpective iſlands as they occur in the order of the alphabet.

CARIBBIANA, or CARIBIANA, the north-eaſt coaſt of Terra Firma, in South America, otherwiſe called *New* ANDALUSIA.

CARICA, the PAPAW. See BOTANY *Index*.

The fruit of one ſpecies is by the inhabitants of the Caribbee iſlands eaten with pepper and ſugar as melons, but is much inferior to a melon in its native country; but thoſe which have ripened in Britain were deteſtable; the only uſe to which Mr Miller ſays he has known them put was, when they were about half grown, to ſoak them in ſalt water to get out the acrid juice, and then pickle them for onangos, to which they are a good ſubſtitute.

CARICATURA, in painting, denotes the concealment of real beauties, and the exaggeration of blemiſhes, but ſtill ſo as to preſerve a reſemblance of the object. The word is Italian; formed of *carica*, a load, burden, or the like.

CARICOUS, an epithet given to ſuch tumours as reſemble the figure of a fig. They are frequently found in the piles.

CARIES, the corruption or mortification of a bone. See MEDICINE and SURGERY *Index*.

CARIGNAN, a fortified town of Piedmont, ſituated on the river Po, about ſeven miles ſouth of Turin. E. Long. 7. 25. N. Lat. 44. 30. It was taken in 1544 by the French; who demoliſhed the fortifications, but ſpared the caſtle. It was alſo taken, and retaken, in 1691.

CARILLONS, a ſpecies of chimes frequent in the Low Countries, particularly at Ghent and Antwerp, and played on a number of bells in a belfrey, forming a complete ſeries or ſcale of tones and ſemitones, like thoſe on the harpſichord and organ. There are petals communicating with the great bells, upon which the *carilloneur* with his feet plays the baſs to ſprightly airs, performed with the two hands upon the upper ſpecies of keys. Theſe keys are projecting ſticks, wide enough aſunder to be ſtruck with violence and velocity by either of the hands edgewiſe, without the danger of hitting the neighbouring key. The player is provided with a thick leather covering for the little finger of each hand, to guard againſt the violence of the ſtroke. Theſe carillons are heard through a large town.

CARINA, a Latin term, properly ſignifying the *keel* of a ſhip; or that long piece of timber running along the bottom of the ſhip from head to ſtern, upon which the whole ſtructure is built or framed.

Carina is alſo frequently uſed for the whole capacity or bulk of a ſhip: containing the hull or all the ſpace below the deck. Hence the word is alſo ſometimes uſed by a figure for the whole ſhip.

Carina is alſo uſed in the ancient architecture. The Romans gave the name *carina* to all buildings in form of a ſhip, as we ſtill give the name *nave* to the middle or principal vault of our Gothic churches; becauſe it has that figure.

Carina, among anatomiſts, is uſed to denote the *spina dorsi;* as likewiſe for the fibrous rudiments or embryo of a chick appearing in an incubated egg. The carina conſiſts of the entire *vertebræ*, as they appear after ten or twelve days incubation. It is thus called, becauſe crooked in form of the keel of a ſhip.—Botaniſts alſo, for the like reaſon, uſe the word *carina*, to expreſs the lower petalum of a papilionaceous flower.

Carinæ were alſo weepers or women hired among the ancient Romans to weep at funerals: they were thus called from *Caria*, the country whence moſt of them came.

CARINOLA, an epiſcopal town of Italy, in the kingdom of Naples, and Terra di Lavoro. E. Long. 15. 5. N. Lat. 41. 15.

CARINTHIA, a duchy of Germany, in the circle of Auſtria, bounded by the archbiſhopric of Saltzburg on the north, and by Carniola and the Venetian territories on the ſouth, on the weſt by Tyrol, and on the eaſt by Stiria. A part of this country was anciently called *Carnia*, and the inhabitants *Carni;* but the former afterwards obtained the name of *Carinthia*, and the latter *Carantani* or *Carinthi*. The air of this country is cold, and the ſoil in general mountainous and barren; but there are ſome fruitful dales and valleys in it, which produce wheat and other grain. The lakes, brooks, and rivers, which are very numerous, abound with fiſh; and the mountains yield lead and iron, and in many places are covered with woods. The river Drave, which runs acroſs the country, is the moſt conſiderable in Carinthia. The inhabitants are partly deſcendants of the ancient Germans, and partly of the Sclavonians or Wends. The ſtates are conſtituted as in Auſtria, and their aſſemblies are held at Clagenfurt. The archbiſhop of Saltzburg and the biſhop of Bamberg have conſiderable territories in this country. Chriſtianity was planted here in the 7th century. The only profeſſion tolerated at preſent is the Roman Catholic. The biſhops are thoſe of Gurk, and Lavant, who are ſubject to the archbiſhop of Saltzburg. This duchy was formerly a part of Bavaria. In the year 1282, the emperor Rodolph I. gave it to Maynard count of Tyrol, on condition that when his male iſſue failed, it ſhould revert to the houſe of Auſtria; which happened in 1331. Carinthia has its particular governor or *land-captain*, as he is called; and contributes annually towards the expence of the military eſtabliſhment 637,695 florins. Only one regiment of foot is uſually quartered in it.

CARIPI, a kind of cavalry in the Turkiſh army. The caripi to the number of about 1000, are not ſlaves, nor bred up in the ſeraglio, like the reſt; but are generally Moors or renegado Chriſtians, who having followed adventures, being poor, and having their fortune to ſeek by their dexterity and courage, have arrived at the rank of horſe guards to the Grand Signior.

CARISSA. See Botany *Index*.

CARITAS.—The *poculum caritatis*, or grace cup, was an extraordinary allowance of wine or other liquors, wherein the religious at feſtivals drank in commemoration of their founders and benefactors.

CARISBROOK castle, a caſtle ſituated in the middle of the Iſle of Wight, where King Charles I. was impriſoned. W. Long. 1. 30. N. Lat. 50. 40.

CARISTO, an epiſcopal city of Greece, in the eaſtern part of the iſland of Negropont, near Cape Loro. E. Long. 24. 15. N. Lat. 38. 6.

CARKE, denotes the 30th part of a sarplar of wool.

CARLE. See Churl.

CARLETON, Sir Dudley, was born in Oxfordſhire, 1573, and bred in Chriſt-church college. He went as ſecretary to Sir Ralph Winwood into the Low Countries, when King James reſigned the cautionary towns to the States; and was afterwards employed for 20 years as ambaſſador to Venice, Savoy, and the United Provinces. King Charles created him Viſcount Dorcheſter, and appointed him one of his principal ſecretaries of ſtate; in which office he died in 1631. He was eſteemed a good ſtateſman, though an honeſt man; and publiſhed ſeveral political works.

CARLINA, the carline thistle. See Botany *Index*.

CARLINE, or caroline thistle. See Carlina. It is ſaid to have been diſcovered by an angel to Charlemagne, to cure his army of the plague; whence its denomination.

Carline or *Caroline*, a ſilver coin current in the Neapolitan dominions, and worth about 4d. of our money.

Carlines, or Carlings, in a ſhip, two pieces of timber lying fore and aft, along from one beam to another, directly over the keel; ſerving as a foundation for the whole body of the ſhip. On theſe the ledges reſt, whereon the planks of the deck and other matters of carpentry are made faſt. The carlines have their ends let into the beams called *culver-tail-ways*.

Carline *Knees*, are timbers going athwart the ſhip, from the ſides to the hatchway, ſerving to ſuſtain the deck on both ſides.

CARLINGFORD, a port town of Ireland, ſeated on Carlingford bay, in the county of Louth, and province of of Leinſter, 22 miles north of Drogheda. W. Long. 6. 24. N. Lat. 24. 5.

CARLISLE, the capital city of the county of Cumberland, ſeated on the ſouth of the river Eden, and between the Petterel on the eaſt, and the Caude on the weſt. It is ſurrounded by a ſtrong ſtone wall, and has a pretty large caſtle in the weſtern part of it, as alſo a citadel in the eaſtern part, built by Henry VIII. It flouriſhed in the time of the Romans, as appears from the antiquities that are to be met with here, and the Roman coins that have been dug up. At the departure of the Romans this city was ruined by the Scots and Picts; and was not rebuilt till the year 680, by Egfrid, who encompaſſed it with a wall, and repaired the church. In the 8th and 9th centuries, the whole country was again ruined, and the city laid deſolate by the incurſions of the Norwegians and Danes. In this condition it remained till the time of William Rufus; who repaired the walls and the caſtle, and cauſed the houſes to be rebuilt. It was fortified by Henry I. as a barrier againſt Scotland; he alſo placed a garriſon in it, and made it an epiſcopal ſee. It was twice taken by the Scots, and afterwards burnt accidentally in the reign of Richard II. The cathedral, the ſuburbs, and 1500 houſes, were deſtroyed at that time. It is at preſent in a good condition; and has three gates, the Engliſh on the ſouth, the Scotch on the north, and the Iriſh on the weſt. It has two pariſhes, and as many churches, St Cuthbert's and St Mary's, the laſt of which is the cathedral, and is ſeparated from the town by a wall of its own. The eaſtern part, which is the neweſt, is a curious piece of workmanſhip. The choir with the aiſles is 71 feet broad; and has a ſtately eaſt-window 48 feet high and 30 broad, adorned with curious pillars. The roof is elegantly vaulted with wood; and is embelliſhed with the arms of England and France quartered; as alſo with Piercy's, Lucy's, Warren's, Mowbray's, and many others. In the choir are the monuments of three biſhops who are buried there. This ſee was erected in 1133 by King Henry I. and made ſuffragan to the archbiſhop of York. The cathedral church here had been founded a ſhort time before by Walter, deputy in theſe parts for King William Rufus, and by him dedicated to the Virgin Mary. He likewiſe built a monaſtery, and filled it with canons regular of St Auguſtine. This foundation continued till the diſſolution of monaſteries, when its lands were added to the ſee, and the maintenance of a dean, &c. placed here in their room. The church was almoſt ruined by the uſurper Cromwell and his ſoldiers; and has never ſince recovered its former beauty, although repaired after the Reſtoration. This dioceſe contains the greateſt part of the counties of Cumberland and Weſtmorland, in which are only 93 pariſhes; but theſe (as all the northern are) exceeding large; and of them 18 are impropriations. Here is one archdeacon, viz. of Carliſle. The ſee is valued in the king's books at 530l. 4s. 11½d. but is computed to be worth annually 2800l. The clergy's tenth amounts only to 161l. 1s. 7½d. To this cathedral belong a biſhop, a dean, a chancellor, an archdeacon, four prebendaries, eight minor canons, &c. and other inferior officers and ſervants.

The Picts wall, which was built acroſs the country from Newcaſtle, terminates near this place. Carliſle was a fortified place, and ſtill has its governor and lieutenant-governor, but no garriſon. It was taken by the rebels, Nov. 15. 1745; and was retaken by the duke of Cumberland on the 10th of December following, and deprived of its gates. It is governed by a mayor, twelve aldermen, two bailiffs, &c. and has a conſiderable market on Saturdays. The manufactures of Carliſle are chiefly of printed linens, for which near 3000l. per annum is paid in duties. It is alſo noted for a great manufacture of whips, in which a great number of children are employed.—Salmons appear in the Eden in numbers ſo early as the months of December and January; and the London and even Newcaſtle markets are ſupplied with early fiſh from this river: but it is remarkable that they do not viſit the Eſk in any quantity till April; notwithſtanding the mouths of the two rivers are at a ſmall diſtance from each other.—Carliſle ſends two members to parliament, and gives title of earl to a branch of the Howard family.

CARLOCK, in commerce, a ſort of iſinglaſs, made with the ſturgeon's bladder, imported from Archangel. The chief uſe of it is for clarifying wine, but is alſo uſed by the dyers. The beſt carlock comes from Aſtracan, where a great quantity of ſturgeon is caught.

CARLOSTAD, or CARLSTAD, a town of Sweden, in Wermeland, ſeated on the lake Wermer, in E. Long. 14. 4. N. Lat. 59. 16.

CARLOSTAD, or *Carlſtadt*, a town of Hungary, capital of Croatia, and the uſual reſidence of the governors of the province. It is ſeated on the river Kulph, in E. Long. 16. 5. N. Lat. 45. 34.

CARLOWITZ, a ſmall town of Hungary, in Sclavonia, remarkable for a peace concluded here between the Turks and Chriſtians in 1669. It is ſeated on the weſt ſide of the Danube, in E. Long. 19. 5. N. Lat. 45. 25.

CARLSCRONA, or CARLSCROON, a ſea port town in the Baltic, belonging to Sweden. It derives its origin and name from Charles XI. who firſt laid the foundation of a new town in 1680, and removed the fleet from Stockholm to this place, on account of its advantageous ſituation in the centre of the Swediſh ſeas, and the ſuperior ſecurity of its harbour. The greateſt part of Carlſcrona ſtands upon a ſmall rocky iſland, which riſes gently in a bay of the Baltic; the ſuburbs extend over another ſmall rock, and along the mole cloſe to the baſon where the fleet is moored. The way into the town from the main land is carried over a dyke to an iſland, and from thence along two long wooden bridges joined by a barren rock. The town is ſpacious, and contains about 18,000 inhabitants. It is adorned with one or two handſome churches, and a few tolerable houſes of brick; but the generality of the building are of wood. The ſuburbs are fortified towards the land by a ſtone wall. The entrance into the harbour, which by nature is extremely difficult from a number of ſhoals and rocky iſlands, is ſtill further ſecured from the attack of an enemy's fleet by two ſtrong forts built on two iſlands, under the batteries of which all veſſels muſt paſs.

Formerly veſſels in this port when careened and repaired, were laid upon their ſides in the open harbour,

bour, until a dock, according to a plan given by Polheim, was hollowed in the ſolid rock: it was begun in 1714, and finiſhed in 1724; but as it was too ſmall for the admiſſion of men of war, it has lately been enlarged, and is now capable of receiving a ſhip of the firſt rate. But new docks have been begun upon a ſtupendous plan, worthy of the ancient Romans. According to the original ſcheme, it was intended to conſtruct 30 docks, for building and laying up the largeſt ſhips, at the extremity of the harbour. A large baſon, capable of admitting two men of war, is deſigned to communicate, by ſluices, with two ſmaller baſons, from each of which are to extend, like the radii of a circle, five rows of covered docks: each row is to be ſeparated by walls of ſtone; and each dock to be provided with ſluice gates, ſo as to be filled or emptied by means of pumps. Cloſe to the docks, magazines for naval ſtores are to be conſtructed, and the whole to be encloſed with a ſtone wall. The project was begun in 1757; but was much neglected until the acceſſion of his preſent majeſty, who warmly patronized the arduous undertaking. At the commencement of the works, 25,000l. were annnally expended upon them; which ſum has been leſſened to about 6000l. per annum, and the number of docks reduced to 20. The firſt dock was finiſhed in 1779, and it was computed that the whole number would be executed in 20 years.

CARLSTADT, a town of Germany, in the circle of Franconia, and biſhopric of Wurtſburg, ſeated on the the river Maine, in E. Long. 9. 51. N. Lat. 50. 0.

CARLTON, a town in Norfolk held by this tenure, that they ſhall preſent 1000 herrings baked in 14 pyes to the king, wherever he ſhall be when they firſt come in ſeaſon.

CARMAGNIOLA, a fortified town of Italy, in Piedmont, with a good caſtle. It was taken by the French in 1691, and retaken by Prince Eugene the ſame year. It is ſeated in a country abounding in corn, flax, and ſilk, near the river Po, in E. Long. 7. 32. N. Lat. 44. 43.

CARMANIA, in *Ancient Geography*, a country of Aſia, to the eaſt of Perſia, having Parthia to the north, Cedroſia to the eaſt, to the ſouth the Perſian gulf or ſea in part, and in part the Indian, called the *Carmanian Sea*; diſtinguiſhed into *Carmania Deſerta*, and *Carmania Propria*, the former lying to the ſouth of Parthia; and to the ſouth of that, the *Propria*, quite to the ſea. Its name is from the Syriac, *Carma*, ſignifying a "vine," for which that country was famous, yielding cluſters three feet long. Now Kerman, or Carimania, a province of modern Perſia.

CARMEL, a high mountain of Paleſtine, ſtanding on the ſkirts of the ſea, and forming the moſt remarkable headland on all that coaſt. It extends eaſtward from the ſea as far as the plain of Jezreel, and from the city of that name quite to Cæſarea on the ſouth. It ſeems to have had the name of *Carmel* from its great fertility; this word, according to the Hebrew import, ſignifying the *vine of God*, and is uſed in Scripture to denote any fruitful ſpot, or any place planted with fruit trees. This mountain, we are aſſured, was very fertile. Mr Sandys acquaints us, that, when well cultivated, it abounds with olives, vines, and variety of fruits and herbs, both medicinal and aromatic. Others, however, repreſent it as rather dry and barren; which perhaps may have happened from the neglect of agriculture ſo common in all parts of the Turkiſh empire, eſpecially where they are expoſed to the incurſions of the Arabs. Carmel is the name of the mountain, and of a city built on it: as well as of a heathen deity worſhipped in it, but without either temple or ſtatue: though anciently there muſt have been a temple, as we are told that this mountain was a favourite retreat of Pythagoras, who ſpent a good deal of time in the temple, without any perſon with him. But what hath rendered Mount Carmel moſt celebrated and revered both by Jews and Chriſtians, is its having been the reſidence of the prophet Elijah, who is ſuppoſed to have lived there in a cave (which is there ſhown), before he was taken up into heaven.

CARMELITES, an order of religious, making one of the four tribes of mendicants or begging friars; and taking its name from Mount Carmel, formerly inhabited by Elias, Eliſha, and the children of the prophets: from whom this order pretends to deſcend in an uninterrupted ſucceſſion. The manner in which they make out their antiquity has ſomething in it too ridiculous to be rehearſed. Some among them pretend they are deſcendants of Jeſus Chriſt; others go further, and make Pythagoras a Carmelite, and the ancient druids regular branches of their order. Phocos, a Greek monk, ſpeaks the moſt reaſonably. He ſays, that in his time, 1185, Elias's cave was ſtill extant on the mountain; near which were the remains of a building which intimated that there had been anciently a monaſtery; that, ſome years before, an old monk, a prieſt of Calabria, by revelation, as he pretended, from the prophet Elias, fixed there, and aſſembled ten brothers. In 1209, Albert, patriarch of Jeruſalem, gave the ſolitaries a rigid rule, which Papebroch has ſince printed. In 1217, or, according to others, 1226, Pope Honorius III. approved and confirmed it. This rule contained 16 articles; one of which confined them to their cells, and enjoined them to continue day and night in prayer; another prohibited the brethren having any property; another enjoined faſting from the feaſt of the holy croſs till Eaſter, except on Sundays; abſtinence at all times from fleſh was enjoined by another article; one obliged them to manual labour; another impoſed a ſtrict ſilence on them from veſpers till the tierce the next day.

The peace concluded by the emperor Frederic II. with the Saracens, in the year 1229, ſo diſadvantageous to Chriſtendom, and ſo beneficial to the infidels, occaſioned the Carmelites to quit the Holy Land, under Alan the fifth general of the Order. He firſt ſent ſome of the religious to Cyprus, who landed there in the year 1328, and founded a monaſtery in the foreſt of Fortania. Some Sicilians, at the ſame time, leaving Mount Carmel, returned to their own country, where they founded a monaſtery in the ſuburbs of Meſſina. Some Engliſh departed out of Syria, in the year 1240, to found others in England. Others of Provence, in the year 1244, founded a monaſtery in the deſert of Aigualates, a league from Marſeilles: and thus, the number of their monaſteries increaſing, they held their European general chapter in the year 1245, at their monaſtery of Aylesford in England.—This order is ſo much increaſed, that it has, at preſent, 38 provinces, beſides the congregation of Mantua, in which are 54 monaſteries, under a vicar-general; and the congregations of Barefooted Carmelites in Italy and Spain, which have their peculiar general.

After the eſtabliſhment of the Carmelites in Europe, their rule was in ſome reſpects altered; the firſt time, by Pope Innocent IV., who added to the firſt article a precept of chaſtity, and relaxed the 11th, which enjoins abſtinence at all times from fleſh, permitting them, when they travelled, to eat boiled fleſh: this pope likewiſe gave them leave to eat in a common refectory, and to keep aſſes or mules for their uſe. Their rule was again mitigated by the popes Eugenius IV. and Pius II. Hence the order is divided into two branches, viz. *the Carmelites of the ancient obſervance*, called the *moderate*, or *mitigated*; and thoſe *of the ſtrict obſervance*, who are the *barefooted Carmelites;* a reform ſet on foot in 1548, by S. Thereſa, a nun of the convent of Avila, in Caſtile: theſe laſt are divided into two congregations, that of Spain and that of Italy.

The habit of the Carmelites was at firſt white, and the cloak laced at the bottom with ſeveral liſts. But Pope Honorius IV. commanded them to change it for that of the Minims. Their ſcapulary is a ſmall woollen habit of a brown colour, thrown over their ſhoulders. They wear no linen ſhirts; but inſtead of them linſey-woolſey, which they change twice a week in the ſummer, and once a week in the winter.

If a monk of this order lies with a woman, he is prohibited ſaying maſs for three or four years, is declared infamous, and obliged to diſcipline himſelf publicly once a-week. If he is again guilty of the ſame fault, his penance is doubled; and if a third time, he is expelled the order.

CARMEN, an ancient term among the Latins, uſed in a general ſenſe to ſignify a verſe; but more particularly to ſignify a ſpell, charm, form of expiation, or execration, couched in a few words placed in a myſtic order, on which its efficacy depended. Pezron derives the word *carmen* from the Celtic *carm*, the ſhout of joy, or the verſes which the ancient bards ſung to encourage the ſoldiers before the combat.—*Carmen* was anciently a denomination given alſo to precepts, laws, prayers, imprecations, and all ſolemn formulæ couched in a few words placed in a certain order, though written in proſe. In which ſenſe it was that the elder Cato wrote a *Carmen de moribus*, which was not in verſe but in proſe.

CARMENTALIA, a feaſt among the ancient Romans, celebrated annually upon the 11th of January, in honour of Carmenta, or Carmentis, a propheteſs of Arcadia, mother of Evander, with whom ſhe came into Italy 60 years before the Trojan war. The ſolemnity was alſo repeated on the 15th of January, which is marked in the old calendar by *Carmentalia relata*. This feaſt was eſtabliſhed on occaſion of a great fecundity among the Roman dames, after a general reconciliation with their huſbands, with whom they had been at variance, in regard of the uſe of coaches being prohibited them by an edict of the ſenate. This feaſt was celebrated by the women: he who offered the ſacrifices was called *ſacerdos carmentalis*.

CARMINATIVES, medicines uſed in colics, or other flatulent diſorders, to diſpel the wind.

The word comes from the Latin *carminare*, to card or teaze wool, and figuratively to attenuate and diſcuſs wind or vapours, and promote their diſcharge by perſpiration. Though Dr Quincy makes it more myſterious: He ſays it comes from the word *carmen*, taking it in the ſenſe of an invocation or charm; and makes it to have been a general name for all medicines which operated like charms, i. e. in an extraordinary manner. Hence, as the moſt violent pains were frequently thoſe ariſing from pent-up wind, which immediately ceaſe upon diſperſion; the term *carminative* became in a peculiar ſenſe applied to medicines which gave relief in windy caſes, as if they cured by enchantment: but this interpretation ſeems a little too far ſtrained.

CARMINE, a powder of a very beautiful red colour bordering upon purple; and uſed by painters in miniature, though rarely, on account of its great price. The manner of preparing it is kept a ſecret by the colour-makers; neither do any of thoſe receipts which have for a long time been publiſhed concerning the preparation of this and other colours at all anſwer the purpoſe. See COLOUR-*making*.

CARMONA, a town of Italy in Friuli, and in the county of Goritz, ſeated on a mountain near the river Indri. It belongs to the houſe of Auſtria. E. Long. 5. 37. N. Lat. 46. 15.

CARMONA, an ancient town of Spain, in Andaluſia. The gate towards Seville is one of the moſt extraordinary pieces of antiquity in all Spain. It is ſeated in a fertile country, 15 miles eaſt of Seville. W. Long, 5. 37. N. Lat. 37. 34.

CARNATION. See DIANTHUS, BOTANY *Index*.

CARNATION *Colour*, among painters, is underſtood of all the parts of a picture, in general, which repreſent fleſh, or which are naked and without drapery. Titian and Corregio in Italy, and Rubens and Vandyke in Flanders, excelled in carnations.—In colouring for fleſh, there is ſo great a variety, that it is hard to lay down any general rules for inſtructions therein; neither are there any regarded by thoſe who have acquired a ſkill this way; the various colouring for carnations may be eaſily produced, by taking more or leſs red, blue, yellow, or biſtre, whether for the firſt colouring, or for the finiſhing; the colour for women ſhould be bluiſh, for children a little red, both freſh and gay; and for men it ſhould incline to yellow, eſpecially if they are old.

CARNATION, among dyers. To dye a carnation, or red roſe colour, it is directed to take liquor of wheat bran a ſufficient quantity, alum three pounds, tartar two ounces; boil them, and enter 20 yards of broad cloth; after it has boiled three hours, cool and waſh it: take freſh clear bran liquor a ſufficient quantity, madder five pounds; boil and ſodden according to art. —The Bow dyers know that the ſolution of tin, being put in a kettle to the alum and tartar, in another proceſs, makes the cloth, &c. attract the colour into it, ſo that none of the cochineal is left, but the whole is abſorbed by the cloth.

CARNEADES, a celebrated Greek philoſopher, was a native of Cyrene in Africa, and founder of the third academy. He was ſo fond of ſtudy, that he not only avoided all entertainments, but forgot even to eat at his own table; his maid-ſervant Meliſſa was obliged

ged to put the victuals into his hand. He was an antagoniſt of the Stoics; and applied himſelf with great eagerneſs to refute the works of Chryſippus, one of the moſt celebrated philoſophers of their ſect. The power of his eloquence was dreaded even by a Roman ſenate. The Athenians being condemned by the Romans to pay a fine of 500 talents for plundering the city of Oropus, ſent ambaſſadors to Rome, who got the fine mitigated to 100 talents. Carneades the Academic, Diogenes the Stoic, and Critolaus the Peripatetic, were charged with this embaſſy. Before they had an audience of the ſenate, they harangued to great multitudes in different parts of the city. Carneades's eloquence was diſtinguiſhed from that of the others by its ſtrength and rapidity. Cato the Elder made a motion in the ſenate that theſe ambaſſadors ſhould be immediately ſent back, becauſe it was very difficult to diſcern the truth through the arguments of Carneades. The Athenian ambaſſadors (ſaid many of the ſenators) were ſent rather to force us to comply with their demands, than to ſolicit them by perſuaſion; meaning, that it was impoſſible to reſiſt the power of that eloquence with which Carneades addreſſed himſelf to them. According to Plutarch, the youth at Rome were ſo charmed by the orations of this philoſopher, that they forſook their exerciſes and other diverſions, and were carried with a kind of madneſs to philoſophy; the humour of philoſophizing ſpreading like enthuſiaſm. This grieved Cato, who was particularly afraid of the ſubtility of wit and ſtrength of argument with which Carneades maintained either ſide of a queſtion. Carneades harangued in favour of juſtice one day, and the next day againſt it, to the admiration of all who heard him, among whom were Galba and Cato, the greateſt orators of Rome. This was his element; he delighted in demoliſhing his own work; becauſe it ſerved in the end to confirm his grand principle, that there are only probabitities or reſemblances of truth in the mind of man; ſo that of two things directly oppoſite, either may be choſen indifferently. Quintilian remarks, that though Carneades argued in favour of injuſtice, yet he himſelf acted according to the ſtrict rules of juſtice. The following was a maxim of Carneades: "If a man privately knew that his enemy, or any other perſon whoſe death might be of advantage to him, would come to ſit down on graſs in which there lurked an aſp, he ought to give him notice of it, though it were in the power of no perſon whatever to blame him for being ſilent." Carneades, according to ſome, lived to be 85 years old; others make him to be 90: his death is placed in the 4th year of the 162d Olympiad.

CARNEDDE, in Britiſh antiquity, denote heaps of ſtones, ſuppoſed to be druidical remains, and thrown together on occaſion of confirming and commemorating a covenant, Gen. xxxi, 46. They are very common in the iſle of Angleſey, and were alſo uſed as ſepulchral monuments, in the manner of *tumuli*; for Mr Rowland found a curious urn in one of theſe carnedde. Whence it may be inferred, that the Britons had the cuſtom of throwing ſtones on the deceaſed. From this cuſtom is derived the Welſh proverb, *Karn ardyben*, "Ill betide thee."

CARNEIA, in antiquity, a feſtival in honour of Apollo, ſurnamed Carneus, held in moſt cities of Greece, but eſpecially at Sparta, where it was firſt inſtituted.

The reaſon of the name, as well as the occaſion of the inſtitution, is controverted. It laſted nine days, beginning on the 13th of the month Carneus. The ceremonies were an imitation of the method of living and diſcipline uſed in camps.

CARNEL.—The building of ſhips firſt with their timber and beams, and after bringing on their planks, is called *carnel work*, to diſtinguiſh it from clinch work.

Veſſels alſo which go with mizen ſails inſtead of main ſails are by ſome called carnels.

CARNELIAN, in *Natural Hiſtory*, a precious ſtone, of which there are three kinds, diſtinguiſhed by three colours, a red, a yellow, and a white. The red is very well known among us; is found in roundiſh or oval maſſes, much like our common pebbles; and is generally met with between an inch and two or three inches in diameter; it is of a fine, compact, and cloſe texture; of a gloſſy ſurface; and, in the ſeveral ſpecimens, is of all the degrees of red, from the paleſt fleſh-colour to the deepeſt blood-red. It is generally free from ſpots, clouds, or variegations: but ſometimes it is veined very beautifully with an extremely pale red, or with white; the veins forming concentric circles, or other leſs regular figures, about a nucleus, in the manner of thoſe of agates. The pieces of carnelian, which are all one colour, and perfectly free from veins, are thoſe which our jewellers generally make uſe of for ſeals, though the variegated ones are much more beautiful. The carnelian is tolerably hard, and capable of a very good poliſh: it is not at all affected by acid menſtruums: the fire diveſts it of a part of its colour, and leaves it of a pale red; and a ſtrong and long-continued heat will reduce it to a pale dirty gray.

The fineſt carnelians are thoſe of the Eaſt Indies; but there are very beautiful ones found in the rivers of Sileſia and Bohemia; and we have ſome not deſpicable ones in England.

Though the ancients have recommended the carnelian as aſtringent, and attributed a number of fanciful virtues to it, we know of no other uſe of the ſtone than the cutting ſeals on it; to which purpoſe it is excellently adapted, as being not too hard for cutting, and yet hard enough not to be liable to accidents, to take a good poliſh, and to ſeparate eaſily from the wax.

CARNERO, in *Geography*, a name given to that part of the gulf of Venice which extends from the weſtern coaſt of Iſtria to the iſland of Groſſa and the coaſt of Morlachia.

CARNERO is likewiſe the name of the cape to the weſt of the mouth of the bay of Gibraltar.

CARNIFEX, among the Romans, the common executioner. By reaſon of the odiouſneſs of his office, the carnifex was expreſsly prohibited by the laws from having his dwelling houſe within the city. In middle-age writers carnifex alſo denotes a butcher.

Under the Anglo-Daniſh kings, the carnifex was an officer of great dignity; being ranked with the archbiſhop of York, Earl Goodwin, and the lord ſteward. Flor. Wigorn. ann. 1040, *Rex Hardecanutus, Alfricum Ebor. Archiep. Goodwinum comitem, Edricum dispensa-*

torem, Throno suum carnificem, *et alios magnæ dignitatis victor Londinum misit.*

CARNIOLA, a duchy of Germany, bounded on the ſouth by the Adriatic ſea, and that part of Iſtria poſſeſſed by the republic of Venice; on the north, by Carinthia and Stiria; on the eaſt, by Sclavonia and Croatia; on the weſt, by Friuli, the county of Gorz or Goritz, and a part of the gulf of Venice; extending in length about 110 miles, and in breadth about 50. It had its ancient name *Carnia*, as well as the modern one *Carniola*, from its ancient inhabitants the *Carni*, a tribe of Scythians, otherwiſe called *Japides*, whence this and the adjacent countries were alſo called *Japidia*.

Carniola is full of mountains, ſome of which are cultivated and inhabited, ſome covered with wood, others naked and barren, and others continually buried in ſnow. The valleys are very fruitful. Here are likewiſe mines of iron, lead, and copper; but ſalt muſt be had from the ſovereign's magazines. There are ſeveral rivers, beſides many medical ſprings and inland lakes. The common people are very hardy, going barefooted in winter through the ſnow, with open breaſts, and ſleeping on a hard bench without bed or bolſter. Their food is alſo very coarſe and mean. In winter, when the ſnow lies deep on the ground, the mountaineers bind either ſmall baſkets, or long thin narrow boards, like the Laplanders, to their feet, on which, with the help of a ſtout ſtaff or pole, they deſcend with great velocity from the mountains When the ſnow is frozen, they make uſe of a ſort of irons or ſkaits. In different parts of the country the inhabitants, eſpecially the common ſort, differ greatly in their dreſs, language, and manner of living. In Upper and Lower Carniola they wear long beards. The languages chiefly in uſe are the Sclavonian or Wendiſh, and German; the firſt by the commonality, and the latter by people of faſhion. The duchy is divided into the Upper, Lower, Middle, and Inner, Carniola. The principal commodities exported hence are, iron, ſteel, lead, quickſilver, white and red wine, oil of olives, cattle, ſheep, cheeſe, linen, and a kind of woollen ſtuff called *mahalan*, Spaniſh leather, honey, walnuts, and timber; together with all manner of woodwork, as boxes, diſhes, &c. Chriſtianity was firſt planted here in the eighth century. Lutheraniſm made a conſiderable progreſs in it; but, excepting the Walachians or Uſkokes, who are of the Greek church, and ſtyle themſelves *Staraverzi*, i. e. old believers, all the inhabitants at preſent are Roman Catholics. Carniola was long a marquiſate or margravate; but in the year 1231 was erected into a duchy. As its proportion towards the maintenance of the army, it pays annually 363,171 florins: but only two regiments of foot are quartered in it.

CARNIVAL, or CARNAVAL, a time of rejoicing, a ſeaſon of mirth, obſerved with great ſolemnity by the Italians, particularly at Venice, holding from the twelfth day till Lent.

The word is formed from the Italian *Carnavalle*; which M. Du Cange derives from *Carn-a-val*, by reaſon the fleſh then goes to pot, to make amends for the ſeaſon of abſtinence then enſuing. Accordingly, in the corrupt Latin, he obſerves, it was called *Carnelevamen* and *Carniſprivium*; as the Spaniards ſtill denominate it *carnes tollendas*.

Feaſts, balls, operas, concerts of muſic, intrigues, marriages, &c. are chiefly held in carnival time. The carnival begins at Venice the ſecond holiday in Chriſtmas: Then it is they begin to wear maſks, and open their playhouſes and gaming houſes; the place of St Mark is filled with mountebanks, jack-puddings, pedlars, whores, and ſuch like mobs, who flock thither from all parts. There have been no leſs then ſeven ſovereign princes and 30,000 foreigners here to partake of theſe diverſions.

CARNIVOROUS, an epithet applied to thoſe animals which naturally ſeek and feed on fleſh.

It has been a diſpute among naturaliſts, whether man is naturally carnivorous. Thoſe who take the negative ſide of the queſtion, inſiſt chiefly on the ſtructure of our teeth, which are moſtly inciſores or molares; not ſuch as *carnivorous* animals are furniſhed with, and which are proper to tear fleſh in pieces: to which it may be added, that, even when we do feed on fleſh, it is not without a preparatory alteration by boiling, roaſting, &c. and even then that it is the hardeſt of digeſtion of all foods. To theſe arguments Dr Wallis ſubjoins another, which is, that all quadrupeds which feed on herbs or plants have a long colon, with a cæcum at the upper end of it, or ſomewhat equivalent, which conveys the food by a long and large progreſs, from the ſtomach downwards, in order to its ſlower paſſage and longer ſtay in the inteſtines: but that, in *carnivorous* animals, ſuch cæcum is wanting, and inſtead thereof there is a more ſhort and ſlender gut, and a quicker paſſage through the inteſtines Now in man, the cæcum is very viſible: a ſtrong preſumption that nature, who is ſtill conſiſtent with herſelf, did not intend him for a *carnivorous* animal.—It is true, the cæcum is but ſmall in adults, and ſeems of little or no uſe; but in a fœtus it is much larger in proportion: And it is probable, our cuſtomary change of diet, as we grow up, may occaſion this ſhrinking. But to theſe arguments Dr Tyſon replies, that if man had been by nature deſigned not to be *carnivorous*, there would doubtleſs have been found, ſomewhere on the globe, people who do not feed on fleſh; which is not the caſe. Neither are carnivorous animals always without a colon and cæcum; nor are all animals carnivorous which have theſe parts: the opoſſum, for inſtance, hath both a colon and cæcum, and yet feeds on poultry and other fleſh; whereas the hedgehog, which has neither colon nor cæcum, and ſo ought to be carnivorous, feeds only on vegetables. Add to this, that hogs which have both, will feed upon fleſh when they can get it; and rats and mice, which have large cæcums, will feed on bacon as well as bread and cheeſe. Laſtly, the human race are furniſhed with teeth neceſſary for the preparation of all kinds of foods; from whence it would ſeem that nature intended we ſhould live on all. And as the alimentary duct in the human body is fitted for digeſting all kinds of foods, ought we not rather to conclude that nature did not intend to deny us any?

It is no leſs diſputed whether mankind were *carnivorous* before the flood. St Jerome, Chryſoſtome, Theodore, and other ancients, maintain, that all animal food was then forbidden; which opinion is alſo ſtrenuouſly ſupported among the moderns by Curcellæus, and refuted by Heidegger, Danzius, Bochart, &c. See ANTEDILUVIANS.

CARNOSITY is uſed by ſome authors for a little fleſhy excreſcence, tubercle, or wen, formed in the urethra, the neck of the bladder, or yard, which ſtops the paſſage of the urine.—Carnoſities are very difficult of cure: they are not eaſily known but by introducing a probe into the paſſage, which there meets with reſiſtance. They uſually ariſe from ſome venereal malady ill managed.

CARO, ANNIBAL, a celebrated Italian poet, was born at Civita Nuovo in 1507. He became ſecretary to the duke of Parma, and afterwards to Cardinal Farneſe. He was alſo made a knight of Malta. He tranſlated Virgil's Æneid into his own language, with ſuch propriety and elegance of expreſſion, that he was allowed by the beſt judges to have equalled the original. He alſo tranſlated Ariſtotle's rhetoric, two orations of Gregory Nazianzen, with a diſcourſe of Cyprian. He wrote a comedy; and a miſcellany of his poems was printed at Venice in 1584. He died at Rome in 1566.

CAROLINA, a province of North America, comprehending the moſt weſterly part of Florida, and lying between 29 and 36 degrees of N. Lat. It is bounded on the eaſt by the Atlantic, and on the weſt by the river Miſſiſſippi, on the north by Virginia, on the ſouth by Georgia, and to the ſouth of Georgia by the Floridas.

This country is ſeated between the extremities of heat and cold, though the heat is more troubleſome in ſummer than the cold in winter; their winters being very ſhort, and the froſty mornings frequently ſucceeded by warm days. The air is generally ſerene and clear the greateſt part of the year; but in February and March the inhabitants have a cuſtom of burning the woods, which cauſes ſuch a ſmoke as to ſtrangers would ſeem to proceed from a fog or thickneſs in the air. The ſmoke of the tar-kilns likewiſe deceives ſtrangers, and gives them an ill opinion of the air of Carolina; to which alſo conduces a cuſtom of the Indians of ſetting fire to the woods in their huntings, for many miles round. The great rains are in winter, though they are not without heavy ſhowers at midſummer; add to theſe the conſtant dews that fall in the night, which refreſh the ground and ſupply the plants with moiſture. In North Carolina, the north-weſt winds in the winter occaſion very pinching weather; but they are not of long continuance. Weſterly winds bring very pleaſant weather; but the ſoutherly are hot and unwholeſome, occaſioning fevers and other diſorders. But this muſt be underſtood of ſummer, for in winter they are very comfortable. The depth of winter is towards the latter end of February and then the ice is not ſtrong enough to bear a man's weight. In Auguſt and September there are ſome times great ſtorms and ſqualls of wind, which are ſo violent as to make lanes of 100 feet wide, more or leſs, through the woods, tearing up the trees by the roots. Theſe ſtorms generally happen once in about ſeven years; and are attended with dreadful thunder, lightning, and heavy rains. They commonly happen about the time of the hurricanes which rage ſo fatally among the iſlands between the tropics; and ſeem to be occaſioned by them, or to proceed from the ſame cauſe: but by the time they reach Carolina, their force is much abated; and the farther north they proceed, ſo much the more do they decreaſe in fury. The ſoil on the coaſt is ſandy; but farther up, the country is ſo fruitful that they have not yet been at the trouble to manure the land. The grains moſt cultivated are Indian corn and rice, though any ſort will thrive well enough; they have alſo pulſe of ſeveral ſorts, little known in England. All kinds of garden ſtuff uſual in England are cultivated here, and may be had in great plenty. They export large quantities yearly of rice, pitch, tar, turpentine, deer-ſkins, and timber for building; cypreſs, cedar, ſaſſafras, oak, walnut, and pine. Beſides theſe, they alſo ſend out beef, pork, tallow, hides, furs, wheat, peas, potatoes, honey, bees-wax, myrtle-wax, tobacco, ſnakeroot, cotton, ſeveral ſorts of gums and medicinal drugs. Indigo is alſo cultivated in this province, but of an inferior quality to that which comes from the Caribbee iſlands. It hath been attempted in vain to cultivate vines, and produce ſilk, in this country; for though the froſts here do not continue long without intervals of warmer weather, they are ſufficient to check the growth of the vine, as well as olives, dates, oranges, &c. The furs are bought of the Indians with vermilion, lead, gunpowder, coarſe cloth, iron, and ſpirituous liquors. As yet they have not a ſufficient number of handicraftsmen; which renders labour very dear, and a ſupply of clothes from Europe neceſſary. The aſpect of the country is very fine, being adorned with beautiful rivers and creeks, and the woods with lofty timber, which afford delightful and pleaſant ſeats for the planters, and render the fencing their lands very eaſy. And as they have plenty of fiſh, wild-fowl, and veniſon, beſides other neceſſaries which this country produces naturally, they live eaſy and luxuriouſly.

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Their rivers are large, and navigable a great many miles up the country. They riſe near the mountains, and abound with delicate fiſh, beſide water-fowl of different kinds. In ſome there are iſlands which yield good paſture, without the annoyance of wild beaſts. The chief mountains are the Cherokee or Allegany mountains, which are ſituated north and north-weſt, five or ſix hundred miles diſtant from the ſea. They are very high; and abound with trees, plants, ſtones, and minerals, of different kinds,

This country is divided into North and South Carolina, and Georgia; each of which, before the late revolution, was under a particular governor. The North is ſubdivided into four counties, Granville, Colliton, Berkley, and Craven; and South Carolina into two, Clarendon and Albemarle. This laſt is alſo divided into 14 pariſhes or townſhips, each of which has a brick or timber church. The former likewiſe has the ſame number of pariſhes. Charleſtown is the capital of the whole country.

Carolina was diſcovered by Sebaſtian Cabot about the year 1500, in the reign of Henry VII. but the ſettling of it being neglected by the Engliſh, a colony of French Proteſtants, by the encouragement of Admiral Coligni, were tranſported thither; and named the place of their firſt ſettlement *Arx Carolina*, in honour of their prince, Charles IX. of France; but in a ſhort time that colony was deſtroyed by the Spaniards; and no other attempt was made by any European power to ſettle there till the year 1664, when 800 Engliſh landed at Cape Fear in North Carolina, and took poſſeſſion of the country. In 1670 Cha. II. of Britain granted Carolina to the lords Berkely, Clarendon, Albemarle, Craven, and Aſhly, Sir George Carteret, Sir William Berkely, and Sir John Colliton. The plan of government for this new colony was drawn up by the famous Mr Locke, who very wiſely propoſed a univerſal toleration in religious matters. The only reſtriction in this reſpect was, that every perſon claiming the protection of that ſettlement, ſhould, at the age of 17, regiſter himſelf in ſome particular communion. To civil liberty, however, our philoſopher was not ſo favourable; the code of Carolina gave to the eight proprietors who founded the colony, and to their heirs, not only all the rights of a monarch, but all the powers of legiſlation. The court, which was compoſed of this ſovereign body, and called the *Palatinate Court*, was inveſted with the right of nominating to all employments and dignities, and even of conferring nobility; but with new and unprecedented titles. They were, for inſtance, to create in each county two *caciques*, each of whom was to be poſſeſſed of 24,000 acres of land; and a *landgrave*, who was to have 80,000. The perſons on whom theſe honours ſhould be beſtowed were to compoſe the upper houſe, and their poſſeſſions were made unalienable. They had only the right of farming or letting out a third part of them at the moſt for three lives. The lower houſe was compoſed of the deputies from the ſeveral counties and towns. The number of this repreſentative body was to be increaſed as the colony grew more populous. No tenant was to pay more than about a ſhilling per acre, and even this rent was redeemable. All the inhabitants, however, both ſlaves and freemen, were under an obligation to take up arms upon the firſt order from the Palatine court.

It was not long before the defects of this conſtitution became apparent. The proprietary lords uſed every endeavour to eſtabliſh an arbitrary government; and, on the other hand, the coloniſts exerted themſelves with great zeal to avoid ſervitude. In conſequence of this ſtruggle, the whole province, diſtracted with tumults and diſſenſions, became incapable of making any progreſs, though great things had been expected from its particular advantages of ſituation. Though a toleration in religious matters was a part of the original conſtitution, diſſenſions aroſe likewiſe on that account. In 1705, Carteret, now Lord Granville, who, as the oldeſt of the proprietors, was ſole governor of the colony, formed a deſign of obliging all the non-conformiſts to embrace the ceremonies of the Church of England; and this act of violence, though diſavowed and rejected by the mother-country, inflamed the minds of the people. In 1720, while this animoſity was ſtill ſubſiſting, the province was attacked by ſeveral band of ſavages, driven to deſpair by a continued courſe of the moſt attrocious violence and injuſtice. Theſe unfortunate wretches were all put to the ſword: but, in 1728, the lords proprietors having refuſed to contribute towards the expences of an expedition, of which they were to ſhare the immediate benefits, were deprived of their prerogative, except Lord Granville, who ſtill retained his eighth part. The reſt received a recompenſe of about 24,000l. The colony was taken under the immediate protection of the crown, and from that time began to flouriſh. The diviſion into North and South Carolina now took place, and the ſettlement of Georgia commenced in 1732. See GEORGIA.

CAROLINE. See CARLINY.

CAROLINE-BOOKS, the name of four books, compoſed by order of Charlemagne, to refute the ſecond council of Nice. Theſe books are couched in very harſh and ſevere terms, containing 120 heads of accuſation againſt the council of Nice, and condemning the worſhip of images.

CAROLOSTADIANS, or CARLOSTADIANS, an ancient ſect or branch of Lutherans, who denied the real preſence of Chriſt in the euchariſt.

They were thus denominated from their leader Andrew Caroloſtadius, who having originally been archdeacon of Wittemberg, was converted by Luther, and was the firſt of all the reformed clergy who took a wife; but diſagreeing afterwards with Luther, chiefly in the point of the ſacrament, founded a ſect apart. The Caroloſtadians are the ſame with what are otherwiſe denominated Sacramentarians, and agree in moſt things with the Zuinglians.

CAROLUS, an ancient Engliſh broad piece of gold ſtruck under Charles I. Its value has of late been at 23s. ſterling, though at the time it was coined it is ſaid to have been rated at 20s.

CAROLUS, a ſmall copper coin, with a little ſilver mixed with it, ſtruck under Charles VIII. of France. The carolus was worth 12 deniers when it ceaſed to be current. Thoſe which are ſtill current in trade in Lorrain, or in ſome neighbouring provinces, go under the name of French ſols.

CAROTIDS in *Anatomy*, two arteries of the neck, which convey the blood from the aorta to the brain; one called the right, and the other the left, carotid.

CARP, in *Ichthyology*, the Engliſh name of a ſpecies of cyprinus. See CYPRINUS, ICHTHYOLOGY *Index*.

The carp is the moſt valuable of all kinds of fiſh for ſtocking of ponds. It is very quick in its growth, and brings forth the ſpawn three times a year, ſo that the increaſe is very great. The female does not begin to breed till eight or nine years old; ſo that in breeding-ponds a ſupply muſt be kept of carp of that age. The beſt judges allow, that, in ſtocking a breed-pond, four males ſhould be allowed to twelve females. The uſual growth of a carp is two or three inches in length in a year; but, in ponds which receive the fattening of common-ſewers, they have been known to grow from five inches to 18 in one year. A feeding-pond of one acre extent will very well feed 300 carp of three years old, 300 of two years, and 400 of one year old. Carp delight greatly in ponds that have marley ſides; they love alſo clay-ponds well ſheltered from the winds and grown with weeds and long graſs at the edges, which they feed on in the hot months. Carp and tench thrive very faſt in ponds and rivers near the ſea, where the water is a little brackiſh; but they are not ſo well taſted as thoſe which live in freſh water. Grains, blood, chicken-guts, and the like, may at times be thrown into carp-ponds, to help to fatten the fiſh. To make them grow large and fat, the growth of graſs under the water ſhould by all means poſſible be encouraged. For this purpoſe, as the water decreaſes in the ſummer, the ſides of the pond left naked and dry ſhould be well raked with an iron rake, to deſtroy all the weeds, and cut up the ſurface of the earth; hay-ſeed ſhould then be ſown plentifully in theſe places; and more ground prepared in the ſame manner, as the water falls more and more away. By this means there will be a fine and plentiful growth of young graſs along the ſides of the pond to the water's edge; and when the rains fill up the pond again, this will be all buried under the water, and will make a feeding-place for the fiſh where they will come early in the morning, and will fatten greatly upon what they find there.

CARPATES, or ALPES BASTARNICE, in *Ancient Geography*, a range of mountains, running out between Poland, Hungary, and Tranſylvania. Now called the Carpathian Mountains.

CARPATHIUM MARE, (Horace, Ovid); the ſea that waſhes the iſland Carpathus.

CARPATHUS, an iſland on the coaſt of Aſia, two hundred ſtadia in compaſs, and an hundred in length. Its name is ſaid to be from its ſituation on the coaſt of Caria. It lies between Rhodes and Crete, in the ſea which, from this iſland, is called the Carpathian ſea, and has to the north the Ionian, to the ſouth the Egyptian, to the weſt the Cretan and African ſeas. It is two hundred furlongs in compaſs, and a hundred in length. It had anciently, according to Strabo, four cities; according to Scylax, only three. Ptolemy mentions but one, which he calls Poſidium. This iſland is now called Scarpanto.

CARPÆA, a kind of dance anciently in uſe among the Athenians and Magneſians, performed by two perſons, the one acting a labourer, the other a robber. The labourer, laying by his arms, goes to ploughing and ſowing, ſtill looking warily about him as if afraid of being ſurpriſed: the robber at length appears; and the labourer, quitting his plough, betakes himſelf to his arms, and fights in defence of his oxen. The whole was performed to the ſound of flutes, and in cadence. Sometimes the robber was overcome and ſometimes the labourer; the victor's reward being the oxen and plough. The deſign of the exerciſe was to teach and accuſtom the peaſants to defend themſelves againſt the attacks of ruffians.

CARPENTER, a perſon who practiſes CARPENTRY. The word is formed from the French *charpentier*, which ſignifies the ſame, formed of *charpente*, which denotes timber; or rather from the Latin *carpentarius*, a maker of *carpenta*, or carriages.

CARPENTER *of a Ship*, an officer appointed to examine and keep in order the frame of a ſhip, together with her maſts, yards, boats, and all other wooden machinery. It is his duty in particular to keep the ſhip *tight*; for which purpoſe he ought frequently to review the decks and ſides, and to caulk them when it is neceſſary. In the time of battle, he is to examine up and down, with all poſſible attention, in the lower apartments of the ſhip, to ſtop any holes that may have been made by ſhot, with wooden plugs provided of ſeveral ſizes.

CARPENTRAS, an epiſcopal town of France, in the department of Vaucluſe, and capital of Venaiſſin. It is ſubject to the pope; and is ſeated on the river Auſon, at the foot of a mountain. E. Long. 5. 6. N. Lat. 44. 4.

CARPENTRY, the art of cutting, framing, and joining large pieces of wood, for the uſes of building. It is one of the arts ſubſervient to architecture, and is divided into houſe-carpentry and ſhip-carpentry: the firſt is employed in raiſing, roofing, flooring of houſes, &c. and the ſecond in the building of ſhips †, barges, &c. The rules in carpentry are much the ſame with thoſe of JOINERY; the only difference is, that carpentry is uſed in the larger and coarſer work, and joinery in the ſmaller and curious. See CENTRE, ROOF, and STRENGTH *of Materials*.

† See *Ship-Building*.

CARPENTUM, in *Antiquity*, a name common to divers ſorts of vehicles, anſwering to coaches as well as waggons, or even carts, among us. The carpentum was originally a kind of car or vehicle in which the Roman ladies were carried; though in after times it was alſo uſed in war. Some derive the word from *carro*; others from *Carmenta* the mother of Evander, by a converſion of the *m* into *p*.

CARPET, a ſort of covering of ſtuff, or other materials, wrought with the needle or on a loom, which is part of the furniture of a houſe, and commonly ſpread over tables, or laid upon the floor.

Perſian and Turkey carpets are thoſe moſt eſteemed; though at Paris there is a manufactory after the manner of Perſia, where they make them little inferior, not to ſay finer, than the true Perſian carpets. They are velvety, and perfectly imitate the carpets which come from the Levant. There are alſo carpets of Germany, ſome of which are made of woollen ſtuffs, as ſerges, &c. and called ſquare carpets: others are made of wool alſo, but wrought with the needle, and pretty often embelliſhed with ſilk; and, laſtly, there are ſome made of dogs hair. We have likewiſe carpets made in Britain, which are uſed either as floor-carpets, or to cover chairs, &c. It is true, we are not arrived at the like perfection in this manufacture with our neighbours the French; but may not this be owing to the want of a like public encouragement?

CARPET-*Knights*, a denomination given to gown-men and others, of peaceable profeſſions, who, on account of their birth, office, or merits to the public, or the like, are, by the prince, raiſed to the dignity of knighthood.

They take the appellation *carpet*, becauſe they uſually receive their honours from the king's hands in the court, kneeling on a carpet. By which they are diſtinguiſhed from knights created in the camp, or field of battle, on account of their military proweſs. Carpet-knights poſſeſs a medium between thoſe called *truck*, or *dunghill-knights*, who only purchaſe or merit the honour by their wealth, and *knights-bachelors*, who are created for their ſervices in the war.

CARPI, a principality of Modena in Italy, lying about four leagues from that city. It formerly belonged to the houſe of Pio; the elder ſons of which bore the title of *Princes of St Gregory*. In the beginning of the 14th century, *Manfroy* was the firſt prince of Carpi; but in the 16th, the emperor Charles V. gave the principality to Alfonzo duke of Ferrara.

This nobleman, in recompenſe, gave to Albert Pio, to whom the principality of Carpi belonged of right, the town of Saſſuola and ſome other lands. Albert was, however, at laſt obliged to retire to Paris; where, being ſtripped of all his eſtates, he died in 1338, with the reputation of being one of the beſt and braveſt men of his age. The family of Pio is yet in being, and continues attached to the French court. Some of them have even been raiſed to the purple, and ſtill make a figure in Europe.

Carpi, a town of Italy in the duchy of Modena, and capital of the laſt mentioned principality. It has a ſtrong caſtle, and is ſituated in E. Long. 11. 12. N. Lat. 44. 45.

Carpi, a town of the Veroneſe in Italy, memorable for a victory gained by the Imperialiſts over the French in 1701. It is ſubject to the Venetians: and is ſituated on the river Adige, in E. Long. 11. 39. N. Lat. 45. 10.

Carpi, *Ugo de*, an Italian painter, of no very conſiderable talents in that art, but remarkable for being the inventer of that ſpecies of engraving on wood, diſtinguiſhed by the name of chiaro-ſcuro, in imitation of drawing. This is performed by uſing more blocks than one; and Ugo da Carpi uſually had three; the firſt for the outline and dark ſhadows, the ſecond for the lighter ſhadows, and the third for the half tint. In that manner he ſtruck off prints after ſeveral deſigns, and cartoons of Raphael; particularly one of the Sibyl, a Deſcent from the Croſs, and the Hiſtory of Simon the Sorcerer. He died in 1500. This art was brought to a ſtill higher degree of perfection by Balthaſar Peruzzi of Siena, and Parmigiano, who publiſhed ſeveral excellent deſigns in that manner.

Carpi, *Girolamo da*, hiſtory and portrait painter, was born at Ferrara in 1501, and became a diſciple of Garofala. When he quitted that maſter, he devoted his whole time, thoughts, and attention, to ſtudy the works of Correggio, and to copy them with a moſt critical care and obſervation; in which labour he ſpent ſeveral years at Parma, Modena, and other cities of Italy, where the beſt works of that exquiſite painter were preſerved. He acquired ſuch an excellence in the imitation of Correggio's ſtyle, and copying his pictures, that many paintings finiſhed by him were taken for originals, and not only admired, but were eagerly purchaſed by the connoiſſeurs of that time. Nor is it improbable that ſeveral of the paintings of Girolamo de Carpi paſs at this day for the genuine work of Correggio himſelf. He died in 1556.

CARPINUS, the Horn-beam. See Botany *Index*.

CARPOBALSAM, in the *Materia Medica*, the fruit of the tree which yields the true oriental balſam. The carpobalſam is uſed in Egypt, according to Proſper Alpinus, in all the intentions in which the balſam itſelf is applied: but the only uſe the Europeans make of it is in Venice treacle and mithridate: and in theſe not a great deal, for cobubs and juniper-berries are generally ſubſtituted in its place.

CARPOCRATIANS, a branch of the ancient Gnoſtics, ſo called from *Carpocrates*, who in the ſecond century revived and improved upon the errors of Simon Magus, Menander, Saturninos, and other Gnoſtics. He owned, with them, one ſole principle and father of all things, whoſe name as well as nature was unknown. The word, he taught, was created by angels, vaſtly inferior to the firſt principle. He oppoſed the divinity of Jeſus Chriſt; making him a mere man, begotten carnally on the body of Mary by Joſeph, though poſſeſſed of uncommon gifts which ſet him above other creatures. He inculcated a community of women; and taught, that the ſoul could not be purified, till it had committed all kinds of abominations, making that a neceſſary condition of perfection.

CARPOLITI, or Fruit-stone Rocks of the Germans, are compoſed of a kind of jaſper, of the nature of the amygdaloides, or almond-ſtones. Bertrand aſſerts that the latter are thoſe which appear to be compoſed of elliptical pieces like petrified almonds, though, in truth, they are only ſmall oblong pieces of calcareous ſtone rounded by attrition, and ſometimes ſmall muſſel-ſhells connected by a ſtony concretion. The name of Carpolithi, however, is given in general by writers on foſſils to all ſorts of ſtony concretions that have any reſemblance to fruit of whatever kind.

CARPUS, the wrist. See Anatomy *Index*.

CARR, a kind of rolling throne, uſed in triumphs, and at the ſplendid entries of princes. See Chariot.

The word is from the ancient Gauliſh, or Celtic, *Carr;* mentioned by Cæſar, in his Commentaries, under the name *Carrus*. Plutarch relates, that Camillus having entered Rome in triumph, mounted on a carr drawn by four white horſes, it was looked on as too haughty an innovation.

Carr is alſo uſed for a kind of light open chariot. The carr, on medals, drawn either by horſes, lions, or elephants, uſually ſignifies either a triumph or an apotheoſis: ſometimes a proceſſion of the images of the gods at ſolemn ſupplication, and ſometimes of thoſe of ſome illuſtrious family at a funeral. The carr covered, and drawn by mules, only ſignifies a conſecration, and the honour done any one of having his image carried at the gates of the circus. See Consecration, &c.

CARRAC, or Carraca, a name given by the Portugueſe to the veſſels they ſend to Braſil and the Eaſt Indies; being very large, round built, and fitted for fight as well as burden. Their capacity lies in their depth, which is very extraordinary. They are narrower above than underneath, and have ſometimes ſeven or eight floors; they carry about 2000 tons, and are capable of lodging 2000 men; but of late they are little uſed. Formerly they were alſo in uſe among the knights of Rhodes, as well as among the Genoeſe, and other Italians. It is a cuſtom among the Portugueſe, when the carracs returned from India, not to bring any boat or ſloop for the ſervice of the ſhip beyond the iſland of St Helena; at which place they ſink them on purpoſe; in order to take from the crew all hopes or poſſibility of ſaving themſelves, in caſe of ſhipwreck.

CARRARA marble, among our our artificers, the name of a ſpecies of white marble, which is called *marmor lunenſe*, and *liguſtrium* by the ancients: it is diſtinguiſhed from the Parian, now called the ſtatuary marble, by being harder and leſs bright.

CARRAVEIRA a town of Turkey in Europe,

with a Greek archbiſhop's ſee. E. Long. 22. 25. N. Lat. 40. 27.

CARRIAGE, a vehicle ſerving to convey perſons, goods, merchandiſes, and other things, from one place to another.

For the conſtruction and mechanical principles of wheel-carriages, ſee MECHANICS.

CARRIAGE *of a Cannon*, the frame or timber-work on which it is mounted, ſerving to point it for ſhooting, or to carry it from one place to another. It is made of two planks of wood, commonly of one-half the length of the gun, called the *cheeks*, and joined by three wooden tranſums, ſtrengthened with three bolts of iron. It is mounted on two wheels, but on a march has two fore-wheels with limbers added. The principal parts of a carriage are the cheeks, tranſum, bolts, plates, trainbands, bridges, bed, hooks, trunnion holes, and capſquare.

Block-CARRIAGE, a cart made on purpoſe for carrying mortars and their beds from place to place.

Truck-CARRIAGE, two ſhort planks of wood, ſupported on two axletrees, having four trucks of ſolid wood for carrying mortars or guns upon battery, where their own carriages cannot go. They are drawn by men.

CARRICK, the ſouthern diviſion of the ſhire of Ayr in Scotland. It borders on Galloway; ſtretches 32 miles in length; and is a hilly country fit for paſturage. The chief rivers are the Stinchar and Girvan, both abounding with ſalmon. Here are alſo ſeveral lakes and foreſts; and the people on the coaſt employ themſelves in the herring-fiſhery, though they have no harbour of any conſequence. The only towns of this diſtrict are Girvan and Ballantrae; the former at the mouth of the river of the ſame name, and the latter at the mouth of the Stinchar; and Maybole, an inland town. The prince of Wales, as prince of Scotland, is earl of Carrick.

CARRICK *on the Sure*, a town of Ireland, in the county of Tipperary and province of Munſter. W. Long. 7. 14. N. Lat. 52. 16.

CARRICK-*Fergus*, a town of Ireland, in the county of Antrim and province of Ulſter. It is a town and county in itſelf, and ſends two members to parliament. It is very rich and populous, with a good harbour; and is governed by a mayor, recorder, and ſheriffs.—It has, however, been of far greater conſequence than at preſent, as appears from the mayor having been admiral of a conſiderable extent of coaſt in the counties of Down and Antrim, and the corporation enjoying the cuſtoms paid by all veſſels within theſe bounds, the creeks of Belfaſt and Bangor excepted. This grant was repurchaſed, and the cuſtomhouſe transferred to Belfaſt.—Here is the ſkeleton of a fine houſe built by Lord Chicheſter in the reign of James I. an old Gothic church with many family monuments, and a very large old caſtle. The town was formerly walled round, and ſome part of the walls is ſtill remaining entire.—Carrick-fergus is ſeated on a bay of the ſame name in the Iriſh channel; and is noted for being the landing place of King William in 1690. Here alſo Thurot made a deſcent in 1759, took poſſeſſion of the caſtle, and carried away hoſtages for the ranſom of the town; but being ſoon after purſued by Commodore Elliot, his three ſhips were taken, and he himſelf was killed.

CARRIER, is a perſon that carries goods for others for hire. A common carrier, having the charge and carriage of goods, is to anſwer for the ſame, or the value, to the owner. And where goods are delivered to a carrier, and he is robbed of them, he ſhall be charged and anſwer for them, becauſe of the hire. If a common carrier, who is offered his hire, and who has convenience, refuſes to carry goods, he is liable to an action, in the ſame manner as an innkeeper who refuſes to entertain a gueſt. See ASSUMPSIT.

Jacob's Law. Dict.

One brought a box to a carrier, with a large ſum of money, and the carrier demanded of the owner what was in it; he anſwered, that it was filled with ſilks, and ſuch like goods: upon which the carrier took it, and was robbed, and adjudged to make it good; but a ſpecial acceptance, as, *provided there is no charge of money*, would have excuſed the carrier.—A perſon delivered to a carrier's book-keeper two bags of money ſealed up, to be carried from London to Exeter, and told him that it was 200l. and took his receipt for the ſame, with promiſe of delivery for 10s. *per cent* carriage and riſk: though it be proved that there was 400l. in the bags, if the carriage be robbed, he ſhall anſwer only for 200l. becauſe there was a particular undertaking for that ſum and no more; and his reward, which makes him anſwerable, extends no farther. If a common carrier looſes goods which he is intruſted to carry, a ſpecial action on the caſe lies againſt him, on the cuſtom of the realm, and not trover; and ſo of a common carrier by boat. An action will lie againſt a porter, carrier, or barge-man, upon his bare receipt of the goods, if they are loſt through negligence. Alſo a lighter-man ſpoiling goods he is to carry, by letting water come to them, action of the caſe lies againſt him, on the common cuſtom.

CARRIER *Pigeon*, or *courier-pigeon*, a ſort of pigeon uſed, when properly trained, to be ſent with letters from one place to another. See COLUMBA.

Though you carry theſe birds hood-winked, 20, 30, nay, 60 or 100 miles, they will find their way in a very little time to the place where they were bred. They are trained to this ſervice in Turkey and Perſia: and are carried firſt, while young, ſhort flights of half a mile, afterwards more, till at length they will return from the fartheſt part of the kingdom. Every baſhaw has a baſket of theſe pigeons bred in the ſeraglio, which, upon any emergent occaſion, as in inſurrection, or the like, he diſpatches, with letters braced under the wings, to the ſeraglio; which proves a more ſpeedy method, as well as a more ſafe one, than any other; he ſends out more than one pigeon, however, for fear of accidents. Lithgow aſſures us, that one of theſe birds will carry a letter from Babylon to Aleppo, which is 30 days journey, in 48 hours. This is alſo a very ancient practice: Hirtius and Brutus, at the ſiege of Modena, held a correſpondence with one another by means of pigeons. And Ovid tells us, that Tauroſthenes, by a pigeon ſtained with purple, gave notice to his father of his victory at the Olympic Games, ſending it to him at Ægina.

In modern times, the moſt noted were the pigeons of Aleppo, which ſerved as couriers at Alexandretta and Bagdad. But this uſe of them has been laid aſide for the laſt 30 or 40 years, becauſe the Curd robbers killed the pigeons. The manner of ſending advice by them was this: they took pairs which had young ones, and carried them on horſeback to the place from whence they wiſhed them to return, taking care to let them have a full view. When the news arrived, the correſpondent tied a billet to the pigeon's foot, and let her looſe. The bird, impatient to ſee its young, flew off like lightning, and arrived at Aleppo in ten hours from Alexandretta, and in two days from Bagdad. It was not difficult for them to find their way back, ſince Aleppo may be diſcovered at an immenſe diſtance. This pigeon has nothing peculiar in its form, except its noſtrils, which, inſtead of being ſmooth and even, are ſwelled and rough.

CARRON, a ſmall but remarkable river in Scotland, riſing about the middle of the iſthmus between the friths of Forth and Clyde. Both its ſource, and the place where it emptieth itſelf into the ſea, are within the ſhire of Stirling, which it divides into two nearly equal parts. The whole length of its courſe, which is from weſt to eaſt, is not above 14 miles. It falls into the frith of Forth about three miles to the north-eaſt of Falkirk. The ſtream thereof is but ſmall, and ſcarcely deſerves the notice of a traveller; yet there is no river in Scotland, and few in the whole iſland of Britain, whoſe banks have been the ſcene of ſo many memorable tranſactions. When the Roman empire was in all its glory, and had its eaſtern frontiers upon the Euphrates, the banks of Carron were its boundaries upon the north-weſt; weſt for the wall of Antoninus*, which was raiſed to mark the limits of that mighty empire, ſtood in the neighbourhood of this river, and ran parallel to it for ſeveral miles.

Near the middle of its courſe, in a pleaſant valley, ſtand two beautiful mounts, called the *Hills of Dunipace*, which are taken notice of by moſt of the Scottiſh hiſtorians as monuments of great antiquity. The whole ſtructure of theſe mounts is of earth; but they are not both of the ſame form and dimenſions. The more eaſterly one is perfectly round, reſembling an oven, and about fifty feet in height: And that this is an artificial work does not admit of the leaſt doubt; but we cannot affirm the ſame, with equal certainty, of the other, though it has been generally ſuppoſed to be ſo too. It bears no reſemblance to the eaſtern one either in ſhape or ſize. At the foundation it is nearly of a triangular form; but the ſuperſtructure is quite irregular; nor does the height thereof bear any proportion to the extent of its baſe. Theſe mounts are now planted with firs, which, with the pariſh-church of Dunipace ſtanding in the middle between them, and the river running hard by, give this valley a very romantic appearance. The common account given of thoſe mounts is, that they were erected as monuments of a peace concluded in that place between the Romans and the Caledonians, and that their name partakes of the language of both people; *Dun* ſignifying a hill in the old language of this iſland, and *Pax* "peace" in the language of Rome. The compound word, *Dunipace*, ſignifies "the hills of peace." And we find in hiſtory, that no leſs than three treaties of peace were at different periods entered into between the Romans and Caledonians; the firſt by Severus about the year 210; the ſecond ſoon after, by his ſon Caracalla; and the third, by the uſurper Carauſius, about the year 280; but of which of theſe treaties Dunipace is a monument, we do not pretend to determine. If the concurring teſtimony of hiſtorians and antiquaries did not agree in giving this original to theſe mounts, we would be tempted to conjecture that they are ſepulchral monuments. Human bones and urns have been diſcovered in earthen fabrics of this kind in many parts of this iſland, and the little mounts or barrows which are ſcattered in great numbers about Stonhenge in Saliſbury plain are generally ſuppoſed to have been the ſepulchres of the ancient Britons. See BARROWS.

From the valley of Dunipace, the river runs for ſome time in a deep and hollow channel, with ſteep banks on both ſides; here it paſſes by the foundations of the ancient Roman bridge; not far from which, as is generally thought, was the ſcene of the memorable conference betwixt the Scotiſh patriot William Wallace and Robert Bruce, father to the king of that name, which firſt opened the eyes of the latter to a juſt view both of his own true intereſt and that of his country.

After the river has left the village and bridge of Larbert, it ſoon comes up to another ſmaller valley, through the midſt of which it has now worn out to itſelf a ſtraight channel, whereas, in former ages, it had taken a conſiderable compaſs, as appears by the track of the old bed which is ſtill viſible. The high and circling banks upon the ſouth ſide give to this valley the appearance of a ſpacious bay; and, according to the tradition of the country, there was once an harbour here; nor does the tradition ſeem altogether groundleſs, pieces of broken anchors having been found here, and ſome of them within the memory of people yet alive. The ſtream tides would ſtill flow near the place, if they were not kept back by the dam-head built acroſs the river at Stenhouſe; and there is reaſon to believe, that the frith flowed conſiderably higher in former ages than it does at preſent. In the near neighbourhood of this valley, upon the ſouth, ſtands the ruins of ancient Camelon: which, after it was abandoned by the Romans, was probably inhabited, for ſome ages, by the natives of the country.

Another ancient monument, called *Arthur's Oven*, once ſtood upon the banks of the Carron: but was, with a ſpirit truly Gothic, entirely demoliſhed about 40 years ago. The corner of a ſmall incloſure between Stenhouſe and the Carron iron-works, is pointed out as the place of its ſituation. This is generally ſuppoſed to have been a Roman work: though it is not eaſy to conceive what could be their motive for erecting ſuch a fabric, at ſo great a diſtance from any other of their works, and in a ſpot which at that time muſt have been very remote and unfrequented. The form of it is ſaid to have been perfectly round, and riſing perpendicular for ſome yards at firſt, but afterwards gradually contracted, till it terminated in a narrow orifice at the top. Antiquaries are not agreed whether it had been a temple, or a trophy, or a mauſoleum; but the moſt common opinion is, that it had been a temple, and Buchanan thinks, a temple of Terminus. Hector Boetius ſays, that there were benches of ſtone all around it upon the inſide; and that there had been a large

* See *Antoninus's Wall.*

ſtone for ſacrificing upon, or an altar, upon the ſouth ſide.

As the Carron extends over the half of the iſthmus, and runs ſo near the ancient boundaries of the Roman empire, the adjacent country fell naturally to be the ſcene of many battles and rencounters. Hiſtorians mention a bloody battle fought near the river between the Romans and the confederate army of the Scots and Picts in the beginning of the 5th century. The ſcenes of ſome of Oſſian's poems were, in the opinion of the tranſlator, upon the banks of this river. Here Fingal fought with Caracal, the ſon of the king of the world, ſuppoſed to have been the ſame with Caracalla, the ſon of the Roman emperor Severus. Here alſo young Oſcar the ſon of Oſſian, performed ſome of his heroic exploits. Hereabout was the ſtream of Crona, celebrated in the ancient compoſitions of the Gaelic bard; poſſibly that now called the water of Bonny, which runs in the neighbourhood of the Roman wall, and diſchargeth itſelf into the Carron at Dunipace. In thoſe poems, mention is made of a green vale upon the banks of this river, with a tomb ſtanding in the middle of it, where young Oſcar's party and the warriors of Caros met. We only take notice of this as it ſtrengthens the conjecture hazarded above, that the mounts of Dunipace, eſpecially the more eaſterly of them, were ſepulchral monuments.—About the diſtance of half a mile from the river, and near the town of Falkirk, lies the field of that battle which was fought by William Wallace and the Engliſh in the beginning of the 14th century. It goes by the name of *Graham's muir*, from the valiant John Graham, who fell there, and whoſe grave-ſtone is ſtill to be ſeen in the church-yard of Falkirk.

The river Carron, though it has long ſince ceaſed to roll its ſtream amidſt the din of arms, ſtill preſerves its fame, by lending its aid to trade and manufactures; (ſee the next article.)—The river is navigable for ſome miles near its mouth, and a conſiderable trade is carried on upon it by ſmall craft; for the convenience of which, its channel has of late years been ſtraightened and much ſhortened, and the great Canal * has its entrance from it.

CARRON-*Works*, a large iron-foundery, two miles north from Falkirk in Scotland. They are conveniently ſituated on the banks of the Carron, three miles above its entry into the frith of Forth. Above 100 acres of land have been converted into reſervoirs and pools, for water diverted from the river, by magnificent dams built above two miles above the works, which, after turning 18 large wheels for the ſeveral purpoſes of the manufacture, falls into a tide-navigation that conveys their caſtings to the ſea.

Theſe works are the greateſt of the kind in Europe, and were eſtabliſhed in 1760. At preſent, the buildings are of vaſt extent; and the machinery, conſtructed by Mr Smeaton, is the firſt in Britain, both in elegance and correctneſs: there are 1600 men employed, to whom is paid weekly above 650l. ſterling; which has greatly enriched the adjoining country; 6500 tons of iron are ſmelted annually from the mineral with pit-coal, and caſt into cannon, cylinders, &c.—In the founding of cannon, theſe works have lately arrived at ſuch perfection, that they make above 5000 pieces a-year, many of which are exported to foreign ſtates; and their guns of *new conſtruction* are the lighteſt and neateſt now in uſe, not excepting braſs guns; the 32 pounder ſhip-gun weighing 42 hundred weight, the 6 pounder 8 hundred-weight and one-half, and the other calibers in proportion.

The preſent proprietors are a chartered company, with a capital of 150,000l. ſterling, a common ſeal, &c. but their ſtock is confined to a very few individuals.

CARRONADE, a ſhort kind of ordnance, capable of carrying a large ball, and uſeful in cloſe engagements at ſea. It takes its name from Carron, the place where this ſort of ordnance was firſt made, or the principle applied to an improved conſtruction. See the article GUNNERY.

CARROT. See DAUCUS, BOTANY *Index*.

Deadly CARROT. See THAPSIA, BOTANY *Index*.

CARROUSAL, a courſe of horſes and chariots, or a magnificent entertainment exhibited by princes on ſome public rejoicing. It conſiſts in a cavalcade of ſeveral gentlemen, richly dreſſed and equipped after the manner of ancient cavaliers, divided into ſquadrons meeting in ſome public place, and practiſing juſts, tournaments, &c.---The laſt carrouſals were in the reign of Louis XIV.---The word comes from the Italian world *caroſello*, a diminutive of *carro*, "chariot." Tertullian aſcribes the invention of carrouſals to Circe; and will have then inſtituted in honour of the Sun, her father; whence ſome derive the word from *carrus*, or *carrus ſolis*. The Moors introduced ciphers, liveries, and other ornaments of their arms, with trappings, &c. for their horſes. The Goths added creſts, plumes, &c.

CARRUCA, in *Antiquity*, a ſplendid kind of carr, or chariot, mounted on four wheels, richly decorated with gold, ſilver, ivory, &c. in which the emperors, ſenators and people of condition, were carried. The word comes from the Latin *carrus*, or Britiſh *carr*, which is ſtill the Iriſh name for any wheel-carriage.

CARRUCA, or *Coruca*, is alſo uſed in middle age writers for a plough.

CARRUCA, or *Caruca*, alſo was ſometimes uſed for *carrucata*. See CARRUCATE.

CARRUCAGE (*carucagium*), a kind of tax anciently impoſed on every plough, for the public ſervice. See CARRUCATE and HIDAGE.

CARRUCAGE, *Carucage*, or *Caruage*, in huſbandry, denotes the ploughing of ground, either ordinary, as for grain, hemp, and flax; or extraordinary, as for woad, dyers weed, rape, and the like.

CARRUCATE, (*carrucata*), in our ancient laws and hiſtory, denotes a plough land, or as much arable ground as can be tilled in one year with one plough.

In Doomſday Inquiſition, the arable land is eſtimated in carrucates, the paſture in hides, and meadow in acres. Skene makes the *carrucata* the ſame with *hilda*, or *hida terræ*; Littleton the ſame with ſoc.

The meaſure of a carrucate appears to have differed in reſpect of place as well as time. In the reign of Richard I. it was eſtimated at 60 acres, and in another charter of the ſame reign at 100 acres: in the time of Edward I. at 180 acres; and in the 23d of Edward III. a carrucate of land in Burceſter contained 112 acres, and in Middleton 150 acres.

By a ſtatute under William III. for charging per-

* See the article *Canal*.

ſons to the repair of the highways, a plough-land is rated at fifty pounds per annum, and may contain houſes, mills, wood, paſture, &c.

CARRYING, in *Falconry*, ſignifies a hawk's flying away with the quarry. Carrying is one of the ill qualities of a hawk, which ſhe acquires either by a diſlike of the falconer, or not being ſufficiently broke to the lure.

CARRYING, among huntſmen. When a hare runs on rotten ground (or even ſometimes in a froſt), and it ſticks to her feet, they ſay ſhe carries.

CARRYING, among riding-maſters. A horſe is ſaid to carry low, when having naturally an ill-ſhaped neck, he lowers his head too much. All horſes that arm themſelves carry low, but a horſe may carry low without arming. A French branch or gigot is preſcribed as a remedy againſt carrying low.

A horſe is ſaid to carry well, when his neck is raiſed or arched, and he holds his head high and firm, without conſtraint.

CARRYING *Wind*, a term uſed by our dealers in horſes to expreſs ſuch a one as frequently toſſes his noſe as high as his ears, and does not carry handſomely. This is called *carrying wind;* and the difference between carrying in the wind, and beating upon the hand, is this: that the horſe who beats upon the hand, ſhakes the bridle and reſiſts it, while he ſhakes his head; but the horſe that carries in the wind puts up his head without ſhaking, and ſometimes beats upon the hand. The oppoſite to carrying in the wind, is arming and carrying low: and even between theſe two there is a difference in wind.

CARS, or KARS, a conſiderable and ſtrong town of Aſia, in Armenia, ſeated on a river of the ſame name, with a caſtle almoſt impregnable. E. Long. 43. 50. N. Lat. 41. 30.

CARSE, or *Carſe of Gowry*, a diſtrict of Perthſhire in Scotland. It lies on the north ſide of the Tay, and extends 14 miles in length from Dundee to Perth, and is from two to four in breath. It is a rich plain country, cultivated like a garden, and producing as good harveſts of wheat as any in Great Britain. It abounds with all the neceſſaries of life: but, from its low damp ſituation, the inhabitants are ſubject to agues, and the commonalty are in great want of firing. In this diſtrict, not far from the Tay, ſtands the houſe of Errol, which formerly belonged to the earls of that name, the chiefs of the ancient family of Hay, hereditary conſtables of Scotland.

CARSTAIRS, WILLIAM, an eminent Scots divine, whoſe merit and good fortune called him to act in great ſcenes, and to aſſociate with men to whoſe ſociety and intercourſe his birth gave him few pretenſions to aſpire. A ſmall village in the neighbourhood of Glaſgow was the place of his nativity. His father, of whom little is known, exerciſed the functions of a clergyman.

Young Carſtairs turned his thoughts to the profeſſion of theology; and the perſecutions and oppreſſions of government, both in regard to civil and religious liberty, having excited his ſtrongeſt indignation, it became a matter of prudence that he ſhould proſecute his ſtudies in a foreign univerſity. He went accordingly to Utrecht; and his induſtry and attention being directed with ſkill, opened up and unfolded thoſe faculties which he was about to employ with equal honour to his country and himſelf.

During his reſidence abroad, he became acquainted with Penſionary Fagel, and entered with warmth into the intereſt of the prince of Orange. On his return to Scotland to produce a licenſe to teach doctrines which he had ſtudied with the greateſt care, he became diſguſted with the proud and inſolent conduct of Archbiſhop Sharp, and prepared to reviſit Holland; where he knew that religious liberty was reſpected, and where he hoped he might better his condition by the connections he had formed.

His expectations were not vain. His prudence, his reſerve, and his political addreſs, were ſtrong recommendations of him to the prince of Orange; and he was employed in perſonal negotiations in Holland, England, and Scotland. Upon the elevation of his maſter to the Engliſh throne, he was appointed the king's chaplain for Scotland, and employed in ſettling the affairs of that kingdom. William, who carried politics into religion, was ſolicitous that epiſcopacy ſhould prevail there as univerſally as in England. Carſtairs, more verſant in the affairs of his native country, ſaw all the impropriety of this project, and the danger that would ariſe from the enforcing of it. His reaſonings, his remonſtrances, his intreaties, overcame the firmneſs of King William. He yielded to conſiderations founded alike in policy and in prudence; and to Carſtairs Scotland is indebted for the full eſtabliſhment of its church in the Preſbyterian form of government.

The death of King William was a ſevere affliction to him; and it happened before that prince had provided for him with the liberality he deſerved. He was continued, however, in the office of chaplain for Scotland by Queen Anne; and he was invited to accept the principality of the Univerſity of Edinburgh. He was one of the miniſters of the city, and four times moderator of the general aſſembly. Placed at the head of the church, he proſecuted its intereſt with zeal and with integrity. Nor were his influence and activity confined to matters of religion. They were exerted with ſucceſs in promoting the culture of the arts and ſciences. The univerſities of Scotland owe him obligations of the higheſt kind. He procured, in particular, an augmentation of the ſalaries of their profeſſors; a circumſtance to which may be aſcribed their reputation, as it enabled them to cultivate with ſpirit the different branches of knowledge.

A zeal for truth, a love of moderation and order, prudence, and humility, diſtinguiſhed Principal Carſtairs in an uncommon degree. His religion had no mixture of auſterity; his ſecular tranſactions were attended with no imputation of artifice; and the verſatility of his talents made him paſs with eaſe from a court to a college. He was among the laſt who ſuffered torture before the privy council, in order to make him divulge the ſecrets intruſted to him, which he firmly reſiſted; and after the revolution, that inhuman inſtrument the thumb-ſcrew was given to him in a preſent by the council.—This excellent perſon died in 1715; and in 1774 his *State papers and Letters*, with an account of his life, were publiſhed in one vol. 4to. by the Rev. Dr. M'Cormick.

CARSUCAI, RAINIER, a Jeſuit, born at Citerna in Tuſcany, in 1647, was the author of a Latin poem, entitled *Ars bene ſcribendi*, which is eſteemed both for the elegance of the ſtyle and for the excellent precepts it contains. He alſo wrote ſome good epigrams. He died in 1709.

CARTAMA, a town of Spain in the kingdom of Grenada, formerly very conſiderable. It is ſeated at the foot of a mountain, near the river Guadala-Medina, in W. Long. 4. 28. N. Lat. 36. 40.

CART, a land carriage with two wheels, drawn commonly by horſes, to carry heavy goods, &c. from one place to another. The word ſeems formed from the French *charrette*, which ſignifies the ſame, or rather the Latin *carreta*, a diminutive of *carrus*. See CARR.

In London and Weſtminiſter carts ſhall not carry more than twelve ſacks of meal, ſeven hundred and fifty bricks, one chaldron of coals, &c. on pain of forfeiting one of the horſes, (6 Geo. I. cap. 6.) By the laws of the city, carr-men are forbidden to ride either on their carts or horſes. They are to lead or drive them on foot through the ſtreets, on the forfeiture of ten ſhillings. (Stat. 1. Geo. I. cap. 57.) Criminals uſed to be drawn to execution on a cart. Bawds and other malefactors are whipped at the cart's tail.

Scripture makes mention of a ſort of carts or drags uſed by the Jews to do the office of threſhing. They were ſupported on low thick wheels, bound with iron, which were rolled up and down on the ſheaves, to break them, and force out the corn. Something of the like kind alſo obtained among the Romans, under the denomination of *plauſtra*, of which Virgil makes mention, (Georg. I.)

> *Tardaque Eleuſinæ matris volventia plauſtra,*
> *Tribulaque, traheæque.*——

On which Servius obſerves, that *trahea* denotes a cart without wheels, and *tribula* a ſort of cart armed on all ſides with teeth, chiefly uſed in Africa for threſhing corn. The Septuagint and St Jerome repreſent theſe carts as furniſhed with ſaws, inſomuch that their ſurface was beſet with teeth. David having taken Rabbah, the capital of the Ammonites, ordered all the inhabitants to be cruſhed to pieces under ſuch carts, moving on wheels ſet with iron teeth; and the king of Damaſcus is ſaid to have treated the Iſraelites of the land of Gilead in the ſame manner.

CART-*Bote*, in *Law*, ſignifies wood to be employed in making and repairing inſtruments of huſbandry.

CARTS *of War*, a peculiar kind of artillery anciently in uſe among the Scots. They are thus deſcribed in an act of parliament, A. D. 1456: "It is thought ſpeidfull, that the king may requeiſt to certain of the great burrous of the land that are of ony myght, to mak carts of weir, and in ilk cart twa gunnis, and ilk ane to have twa chalmers, with the remnant of the graith that effeirs thereto, and an cunnand man to ſhut thame." By another act, A. D. 1741, the prelates and barons are commanded to provide ſuch carts of war againſt their old enemies the Engliſh.

CARTE, THOMAS, the hiſtorian, was the ſon of Mr Samuel Carte prebendary of Litchfield, and born in 1686. When he was reader in the abbey-church at Bath, he took occaſion in a 30th of January ſermon, 1714, to vindicate Charles I. with reſpect to the Iriſh maſſacre, which drew him into a controverſy with Mr Chandler the diſſenting miniſter; and on the acceſſion of the preſent royal family he refuſed to take the oaths to government, and put on a lay habit. He is ſaid to have acted as a kind of ſecretary to Biſhop Atterbury before his troubles: and in the year 1722, being accuſed of high treaſon, a reward of 1000l. was offered for apprehending him: but Queen Carolina, the great patroneſs of learned men, obtained leave for him to return home in ſecurity. He publiſhed, 1. An edition of Thuanus, in ſeven volumes, folio. 2. The life of the firſt Duke of Ormond, three volumes, folio. 3. The Hiſtory of England, four volumes, folio. 4. A Collection of original Letters and Papers concerning the affairs of England, two volumes octavo; and ſome other works. He died in April 1754. His Hiſtory of England ends in 1654. His deſign was to have brought it down to the Revolution; for which purpoſe he had taken great pains in copying every thing valuable that could be met with in England, Scotland, France, Ireland, &c.---He had (as he himſelf ſays, p. 43. of his Vindication of a full anſwer to a letter from a byſtander), "read abundance of collections relating to the time of King Charles II., and had in his power a ſeries of memoirs from the beginning to the end of that reign, in which all thoſe intrigues and turns at court, at the latter end of that king's life, which Biſhop Burnet, with all his *gout* for tales of ſecret hiſtory, and all his genius for conjectures, does not pretend to account for, are laid open in the cleareſt and moſt convincing manner by the perſon who was moſt affected by them, and had the beſt reaſon to know them."---At his death, all his papers came into the hands of his widow, who afterwards married Mr Jernegan, a member of the church of Rome. They are now depoſited in the Bodleian library, having been delivered by Mr Jernegan to the univerſity, 1778, for a valuable conſideration. Whilſt they were in this gentleman's poſſeſſion, the earl of Hardwick paid 200l. for the peruſal of them. For a conſideration of 300l. Mr Macpherſon had the uſe of them; and from theſe and other materials compiled his hiſtory and ſtate-papers. Mr Carte was a man of a ſtrong conſtitution and indefatigable application. When the ſtudies of the day were over, he would eat heartily; and in converſation was cheerful and entertaining.

CARTE-*Blanche*, a ſort of white paper, ſigned at the bottom with a perſon's name, and ſometimes alſo ſealed with his ſeal, giving another perſon power to ſuperſcribe what conditions he pleaſes. Much like this is the French *blanc ſigne*, a paper without writing, except a ſignature at the bottom, given by contending parties to arbitrators or friends, to fill up with the conditions they judge reaſonable, in order to end the difference.

CARTEL, an agreement between two ſtates for the exchange of their priſoners of war.

CARTEL ſignifies alſo a letter of defiance or a challenge to decide a controverſy either in a tournament or in a ſingle combat. See DUEL.

CARTEL *Ship*, a ſhip commiſſioned in time of war to exchange the priſoners of any two hoſtile powers; alſo to carry any particular requeſt or propoſal from one to another: for this reaſon the officer who commands her is particularly ordered to carry no cargo, ammunition, or implements of war, except a ſingle gun for the purpoſe of firing ſignals.

CARTES, Rene des, deſcended of an ancient family in Touraine in France, was one of the moſt eminent philoſophers and mathematicians in the 17th century. At the Jeſuits College at La Fleche, he made a very great progreſs in the learned languages and polite literature, and became acquainted with Father Marſenne. His father deſigned him for the army; but his tender conſtitution then not permitting him to expoſe himſelf to ſuch fatigues, he was ſent to Paris, where he launched into gaming, in which he had prodigious ſucceſs. Here Marſenne perſuaded him to return to ſtudy; which he purſued till he went to Holland, in May 1616, where he engaged as a volunteer among the Prince of Orange's troops. While he lay in garriſon at Breda, he wrote a *treatiſe on muſic*, and laid the foundation of ſeveral of his works. He was at the ſiege of Rochelle in 1628; returned to Paris; and, a few days after his return, at an aſſembly of men of learning in the houſe of Monſignor Bagni, the Pope's nuncio, was prevailed upon to explain his ſentiments with regard to philoſophy, when the nuncio urged him to publiſh his ſyſtem. Upon this he went to Amſterdam, and from thence to Franeker, where he began his *metaphyſical meditation* , and drew up his *diſcourſe on meteors*. He made a ſhort tour to England; and not far from London, made ſome obſervations coccerning the declination of the magnet. He returned to Holland, where he finiſhed his *treatiſe on the world*.

His books made a great noiſe in France; and Holland thought of nothing but diſcarding the old philoſophy, and following his. Voetius being choſen rector of the univerſity of Utrecht, procured his philophy to be prohibited, and wrote againſt him; but he immediately publiſhed a vindication of himſelf. In 1647, he took a journey into France, where the king ſettled a penſion of 3000 livres upon him. Chriſtina, queen of Sweden, having invited him into that kingdom, he went thither, where he was received with the greateſt civility by her majeſty, who engaged him to attend her every morning at five o'clock, to inſtruct her in philoſophy, and deſired him to reviſe and digeſt all his writings which were unpubliſhed, and to form a complete body of philoſophy from them. She likewiſe propoſed to allow him a revenue, and to form an academy, of which he was to be the director. But theſe deſigns were broken off by his death in 1650. His body was interred at Stockholm, and 17 years afterwards removed to Paris, where a magnificent monument was erected to him in the church of St Geneviɇve du Mont. The great Dr Halley, in a paper concerning optics, obſerves, that though ſome of the ancients mention refraction as an effect of tranſparent mediums, Des Cartes was the firſt who diſcovered the laws of refraction, and reduced dioptrics to a ſcience. As to his philoſophy, Dr Keill, in his introduction to his examination of Dr Burnet's theory of the earth, ſays, that des Cartes was ſo far from applying geometry to natural philoſophy, that his whole ſyſtem is one continued blunder on account of his negligence in that point; the laws obſerved by the planets in their revolutions round the ſun not agreeing with his theory of vortices. His philoſophy has accordingly given way to the more accurate diſcoveries and demonſtrations of the Newtonian ſyſtem.

CARTESIANS, a ſect of philoſophers, who adhered to the ſyſtem of Des Cartes, founded on the two following principles, the one metaphyſical, the other phyſical. The metaphyſical one is, *I think, therefore I am*: the phyſical principle is, that *nothing exiſts but ſubſtance*. Subſtance he makes of two kinds; the one a ſubſtance that thinks, the other a ſubſtance extended; whence actual thought, and actual extenſion, are the eſſence of ſubſtance.

The eſſence of matter being thus fixed in extenſion, the Carteſians conclude that there is no vacuum nor any poſſibility thereof in nature; but that the univerſe is abſolutely full: mere ſpace is excluded by this principle; becauſe extenſion being implied in the idea of ſpace, matter is ſo too. Upon theſe principles the Carteſians explained mechanically how the world was formed, and how the preſent celeſtial phenomena came to take place. See Astronomy *Index*.

1 When founded

CARTHAGE, a famed city of antiquity, the capital of Africa Propria; and which for many years, diſputed with Rome the ſovereignty of the world. According to Velleius Paterculus, this city was built 65, according to Juſtin and Trogus 72, according to others 100 or 140 years before the foundations of Rome were laid. It is on all hands agreed that the Pœnicians were the founders.

2 Eliſa or Dido eſcapes from her brother.

The beginning of the Carthaginian hiſtory, like that of all other nations, is obſcure and uncertain. In the 7th year of Pygmalion king of Tyre, his ſiſter Eliſa, or Dido, is ſaid to have fled, with ſome of her companions and vaſſals, from the cruelty and avarice of her brother, who had put to death her huſband Sichæus in order to get poſſeſſion of his wealth.

She firſt touched at the iſland of Cyprus, where ſhe met with a prieſt of Jupiter, who was deſirous of attending her; to which ſhe readily conſented, and fixed the prieſthood in his family. At that time it was a cuſtom in the iſland of Cyprus, for the young women to go on certain ſtated days, before marriage, to the ſea ſide, there to look for ſtrangers, that might poſſibly arrive on their coaſts, in order to proſtitute themſelves for gain, that they might thereby acquire a dowry. Out of theſe the Tyrians ſelected 80, whom they carried along with them. From Cyprus they ſailed directly for the coaſt of Africa; and at laſt ſafely landed in the province calld *Africa Propria*, not far from Utica, a Phœnician city of great antiquity. The inhabitants received their countrymen with great demonſtrations of joy, and invited them to ſettle among them. The common fable is, that the Phœnicians impoſed upon the Africans in the following manner: They deſired, for their intended ſettlement, only as much ground as an ox's hide would encompaſs. This requeſt the Africans laughed at: but were ſurpriſed, when, upon their granting it, they ſaw Eliſa cut the hide into the ſmalleſt ſhreds, by which means it ſurrounded a large territory; in which ſhe built the citadel called *Byrſa*. The learned, however, are now unanimous in exploding this fable: and it is certain that the Carthaginians for many years paid an annual tribute to the Africans for the ground they poſſeſſed.

3 Builds the citadel Byrſa.

The new city ſoon became populous and flouriſhing, by the acceſſion of the neighbouring Africans, who came thither at firſt with a view of traffic. In a ſhort time it became ſo conſiderable, that *Jarbas*, a neighbouring prince, thought of making himſelf maſter of it without any effuſion of blood. In order to this, he deſired that an embaſſy of ten of the moſt noble Carthaginians might be ſent him; and, upon their arrival, propoſed to them a marriage with Dido, threatening war in caſe of a refuſal. The ambaſſadors, being afraid to deliver this meſſage, told the queen that Jarbas deſired ſome perſon might be ſent him who was capable of civilizing his Africans; but that there was no poſſibility of finding any of her ſubjects who would leave his relations for the converſation of ſuch barbarians. For this they were reprimanded by the queen; who told them that they ought to be aſhamed of refuſing to live in any manner for the benefit of their country. Upon this, they informed her of the true nature of their meſſage from Jarbas; and that, according to her own deciſion, ſhe ought to ſacrifice herſelf for the good of her country.

4 She kills herſelf.

The unhappy queen, rather than ſubmit to be the wife of ſuch a barbarian, cauſed a funeral pile to be erected, and put an end to her life with a dagger.

This is Juſtin's account of the death of Queen Dido, and is the moſt probable; Virgil's ſtory of her amour with Æneas being looked upon as fabulous, even in the days of Macrobius, as we are informed by that hiſtorian. How long monarchical government continued in Carthage, or what happened to this ſtate in its infancy, we are altogether ignorant, by reaſon of the Punic archives being deſtroyed by the Romans; ſo that there is a chaſm in the Carthaginian hiſtory for above 300 years. It, however, appears, that from the very beginning the Carthaginians applied themſelves to maritime affairs, and were formidable by ſea in the time of Cyrus and Cambyſes.

5 Spaniſh mines of vaſt ſervice to the Carthaginians.

From Diodorus Siculus and Juſtin, it appears that the principal ſupport of the Carthaginians were the mines of Spain, in which country they ſeem to have eſtabliſhed themſelves very early. By means of the riches drawn from theſe mines, they were enabled to equip ſuch formidable fleets as we are told they fitted out in the time of Cyrus or Cambyſes. Juſtin inſinuates, that the firſt Carthaginian ſettlement in Spain happened when the city of Gades, now Cadiz, was but of late ſtanding, or even its infancy. The Spaniards finding this new colony begin to flouriſh, attacked it with a numerous army, inſomuch that the inhabitants were obliged to call in the Carthaginians to their aid. The latter very readily granted their requeſt, and not only repulſed the Spaniards, but made themſelves maſters of almoſt the whole province in which their new city ſtood. By this ſucceſs, they were encouraged to attempt the conqueſt of the whole country: but having to do with very warlike nations, they could not puſh their conqueſts to any great length at firſt; and it appears, from the accounts of Livy and Polybius, that the greateſt part of Spain remained unſubdued till the time of Hamilcar, Aſdrubal, and Hannibal.

6 Firſt treaty between Carthage and Rome.

About 503 years before the birth of Chriſt, the Carthaginians entered into a treaty with the Romans. It related chiefly to matters of navigation and commerce. From it we learn that the whole iſland of Sardinia, and part of Sicily, were then ſubject to Carthage; that they were very well acquainted with the coaſts of Italy, and had made ſome attempts upon them before this time: and that, even at this early period, a ſpirit of jealouſy had taken place between the two republics. Some time near this period, the Carthaginians had a mind to diſcontinue the tribute they had hitherto paid the Africans for the ground on which their city ſtood. But, notwithſtanding all their power, they were at preſent unſucceſsful; and at laſt were obliged to conclude a peace, one of the articles of which was, that the tribute ſhould be continued.

7 Sicily invaded by the Carthaginians.

By degrees the Carthaginians extended their power over all the iſlands in the Mediterranean, Sicily excepted; and for the entire conqueſt of this, they made vaſt preparations, about 480 years before Chriſt. Their army conſiſted of 300,000 men; their fleet was compoſed of upwards of 2000 men of war, and 3000 tranſports; and with ſuch an immenſe armament, they made no doubt of conquering the whole iſland in a ſingle campaign. In this, however, they found themſelves miſerably deceived. Hamilcar their general having landed his numerous forces, inveſted Himera, a city of conſiderable importance. He carried on his attacks with the greateſt aſſiduity; but was at laſt attacked in his trenches by Gelon and Theron, the tyrants of Syracuſe and Agrigentum, who gave the Carthaginians one of the greateſt overthrows mentioned in hiſtory.

8 They are utterly deſtroyed.

An hundred and fifty thouſand were killed in the battle and purſuit, and all the reſt taken priſoners; ſo that of ſo mighty an army not a ſingle perſon eſcaped. Of the 2000 ſhips of war and 3000 tranſports, of which the Carthaginian fleet conſiſted, eight ſhips only, which then happened to be out at ſea, made their eſcape: theſe immediately ſet ſail for Carthage; but were all caſt away, and every ſoul periſhed, except a few who were ſaved in a ſmall boat, and at laſt reached Carthage with the diſmal news of the total loſs of the fleet and army. No words can expreſs the conſternation of the Carthaginians upon receiving the news of ſo terrible a diſaſter. Ambaſſadors were immediately diſpatched to Sicily, with orders to conclude a peace upon any terms. They put to ſea without delay; and landing at Syracuſe, threw themſelves at the conqueror's feet.

9 Peace concluded.

They begged Gelon, with many tears, to receive their city into favour, and grant them a peace on whatever terms he ſhould chooſe to preſcribe. He granted their requeſt, upon condition that Carthage ſhould pay him 2000 talents of ſilver to defray the expences of the war; that they ſhould build two temples, where the articles of the treaty ſhould be lodged and kept as ſacred; and that for the future they ſhould abſtain from human ſacrifices. This was not thought a dear purchaſe of a peace for which there was ſuch occaſion; and to ſhow their gratitude for Gelon's moderation, the Carthaginians complimented his wife Demarata with a crown of gold worth 100 talents.

From this time we find little mention of the Carthaginians for 70 years. Some time during this period, however, they had greatly extended their dominions in Africa, and likewiſe ſhaken off the tribute which gave them ſo much uneaſineſs.

10 Diſpute with the Cyreneans.

They had warm diſputes with the inhabitants of Cyrene the capital of Cyrenaica, about a regulation of the limits of

11. Story of the *Philæni*.

of their reſpective territories. The conſequence of theſe diſputes was a war, which reduced both nations ſo low, that they agreed firſt to a ceſſation of arms, and then to a peace. At laſt it was agreed, that each ſtate ſhould appoint two commiſſaries, who ſhould ſet out from their reſpective cities on the ſame day, and that the ſpot on which they met ſhould be the boundary of both ſtates. In conſequence of this, two brothers called *Philæni* were ſent out from Carthage, who advanced with great celerity, while thoſe from Cyrene were much more ſlow in their motions. Whether this proceeded from accident or deſign, or perfidy, we are not certainly informed; but, be this as it will, the Cyreneans, finding themſelves greatly outſtripped by the Philæni, accuſed them of breach of faith, aſſerting that they had ſet out before the time appointed, and conſequently that the convention between their principals was broken. The Philæni deſired them to propoſe ſome expedient whereby their differences might be accommodated; promiſing to ſubmit to it whatever it might be. The Cyreneans then propoſed, either that the Philæni ſhould retire from the place where they were, or that they ſhould be buried alive upon the ſpot. With this laſt condition the brothers immediately complied, and by their death gained a large extent of territory to the country. The Carthaginians ever after celebrated this as a moſt brave and heroic action; paid them divine honours; and endeavoured to immortalize their names by erecting two altars there, with ſuitable inſcriptions upon them.

12. Sicily invaded anew.

About the year before Chriſt 412, ſome diſputes happening between the Egeſtines and Selinuntines, inhabitants of two cities in Sicily, the former called in the Carthaginians to their aſſiſtance; and occaſioned a new invaſion of Sicily by that nation. Great preparations were made for this war: Hannibal, whom they had appointed general, was empowered to raiſe an army equal to the undertaking, and equip a ſuitable fleet. They alſo appointed certain funds for defraying all the expences of the war, intending to exert their whole force to reduce the iſland under their ſubjection.

13. Emporium and Selinis taken;

The Carthaginian general having landed his forces, immediately marched for Selinis. In his way he took Emporium, a town ſituated on the river Mazara; and having arrived at Selinis, he immediately inveſted it. The beſieged made a very vigorous defence; but at laſt the city was taken by ſtorm, and the inhabitants were treated with the utmoſt cruelty. All were maſſacred by the ſavage conqueror, except the women who fled to the temples; and theſe eſcaped, not through the merciful diſpoſition of the Carthaginians, but becauſe they were afraid, that if driven to deſpair they would ſet fire to the temples, and by that means conſume the treaſure they expected to find in thoſe places. Sixteen thouſand were maſſacred; 2250 eſcaped to Agrigentum; and the women and children, about 5000 in number, were carried away captives. At the ſame time the temples were plundered, and the city razed to the ground.

14. as likewiſe Himera.

After the reduction of Selinis, Hannibal laid ſiege to Himera; that city he deſired above all things to become maſter of, that he might revenge the death of his grandfather Hamilcar, who had been ſlain before it by Gelon. His troops, fluſhed with their late ſucceſs, behaved with undaunted courage: but finding his battering engines not to anſwer his purpoſe ſufficiently, he undermined the wall, ſupporting it with large beams of timber, to which he afterwards ſet fire, and thus laid part of it flat on the ground. Notwithſtanding this advantage, however, the Carthaginians were ſeveral times repulſed with great ſlaughter; but at laſt they became maſters of the place, and treated it in the ſame manner as they had done Selinis. After this, Hannibal, diſmiſſing his Sicilian and Italian allies, returned to Africa.

15 Agrigentum beſieged;

16 and taken.

The Carthaginians were now ſo much elated, that they meditated the reduction of the whole iſland. But as the age and infirmities of Hannibal rendered him incapable of commanding the forces alone, they joined in commiſſion with him Imilcar, the ſon of Hanno, one of the ſame family. On the landing of the Carthaginian army, all Sicily was alarmed, and the principal cities put themſelves into the beſt ſtate of defence they were able. The Carthaginians immediately marched to Agrigentum, and began to batter the walls with great fury. The beſieged, however, defended themſelves with incredible reſolution, in a ſally burnt all the machines raiſed againſt their city, and repulſed the enemy with great ſlaughter. The Syracuſans, in the mean time, being alarmed at the danger of Agrigentum, ſent an army to its relief. On their approach they were immediately attacked by the Carthaginians; but after a ſharp diſpute the latter were defeated, and forced to fly to the very walls of Agrigentum, with the loſs of 6000 men. Had the Agrigentine commanders now ſallied out, and fallen upon the fugitives, in all probability the Carthaginian army muſt have been deſtroyed; but, either through fear or corruption, they refuſed to ſtir out of the place, and this occaſioned the loſs of it. Immenſe booty was found in the city; and the Carthaginians behaved with their uſual cruelty, putting all the inhabitants to the ſword, not excepting even thoſe who had fled to the temples.

17 Gela beſieged.

The next attempt of the Carthaginians was deſigned againſt the city of Gela; but the Geleans, being greatly alarmed, implored the protection of Syracuſe: and, at their requeſt, Dionyſius was ſent to aſſiſt them with 2000 foot and 400 horſe. The Geleans were ſo well ſatisfied with his conduct, that they treated him with the higheſt marks of diſtinction; they even ſent ambaſſadors to Syracuſe to return thanks for the important ſervices done them by ſending him thither; and ſoon after he was appointed generaliſſimo of the Syracuſan forces and thoſe of their allies againſt the Carthaginians. In the mean time Imilcar, having razed the city of Agrigentum, made an incurſion into the territories of Gela and Comarina; which having ravaged in a dreadful manner, he carried off ſuch immenſe quantity of plunder, as filled his whole camp. He then marched againſt the city; but though it was but indifferently fortified, he met with a very vigorous reſiſtance; and the place held out for a long time without receiving any aſſiſtance from its allies. At laſt Dionyſius came to its aſſiſtance with an army of 50,000 foot and 1000 horſe. With theſe he attacked the Carthaginian camp, but was repulſed with great loſs; after which, he called a council of war, the reſult of whoſe deliberations was, that ſince the enemy

was

18
Abandoned by its inhabitants.

was ſo much ſuperior to them in ſtrength, it would be highly imprudent to put all to the iſſue of a battle; and therefore that the inhabitants ſhould be perſuaded to abandon the country, as the only means of ſaving their lives. In conſequence of this, a trumpet was ſent to Imilcar to deſire a ceſſation of arms till the next day, in order, as was pretended, to bury the dead, but in reality to give the people of Gela an opportunity of making their eſcape. Towards the beginning of the night the bulk of the citizens left the place; and he himſelf with the army followed them about midnight. To amuſe the enemy, he left 2000 of his light-armed troops behind him, commanding them to make fires all night, and ſet up loud ſhouts as though the army ſtill remained in town. At day-break theſe took the ſame route as their companions, and purſued their march with great celerity. The Carthaginians, finding the city deſerted by the greateſt part of its inhabitants, immediately entered it, putting to death all who had remained; after which, Imilcar having thoroughly plundered it, moved towards Camarina. The inhabitants of this city had been likewiſe drawn off by Dionyſius, and it underwent the ſame fate with Gela.

19
Peace concluded.

Notwithſtanding theſe ſucceſſes, however, Imilcar finding his army greatly weakened, partly by the caſualties of war, and partly by a plague, which broke out in it, ſent a herald to Syracuſe to offer terms of peace. His unexpected arrival was very agreeable to the Syracuſans, and a peace was immediately concluded upon the following terms, viz. That the Carthaginians, beſides their ancient acquiſitions in Sicily, ſhould ſtill poſſeſs the countries of the Silicani, the Selinuntines, the Himereans, and Agrigentines; that the people of Gela and Camarina ſhould be permitted to reſide in their reſpective cities, which yet ſhould be diſmantled, upon their paying an annual tribute to the Carthaginians; that all the other Sicilians ſhould preſerve their independency except the Syracuſans, who ſhould continue in ſubjection to Dionyſius.

20
Dionyſius breaks the treaty.

The tyrant of Syracuse, however, had concluded this peace with no other view than to gain time, and to put himſelf in a condition to attack the Carthaginian territories with greater force. Having accompliſhed this, he acquainted the Syracuſans with his deſign, and they immediately approved of it; upon which he gave up to the fury of the populace the perſons and poſſeſſions of the Carthaginians who reſided in Syracuse, and traded there on the faith of treaties. As there were many of their ſhips at that time in the harbour, laden with cargoes of great value, the people immediately plundered them; and, not content with this, ranſacked all their houſes in a moſt outrageous manner. This example was followed throughout the whole iſland; and in the mean time Dionyſius diſpatched a herald to Carthage, with a letter to the ſenate and people, telling them, that if they did not immediately withdraw their garriſons from all the Greek cities in Sicily, the people of Syracuſe would treat them as enemies. With this demand, however, he did not allow them to comply; for without waiting for any anſwer from Carthage, he advanced with his army to Mount Eryx, near which ſtood the city of Motya, a Carthaginian colony of great importance; and this he immediately inveſted. But ſoon after, leaving his brother Leptines to carry on the attack, he himſelf went with the greateſt part of his forces to reduce the cities in alliance with the Carthaginians. He deſtroyed their territories with fire and ſword, cut down all their trees; and then ſat down before Egeſta and Entella, moſt of the other towns having opened their gates at his approach: but theſe baffling his utmoſt efforts, he returned to Motya, and puſhed on the ſiege of that place with the utmoſt vigour.

Syracuſan ſhips deſtroyed.

The Carthaginians, in the meantime, though alarmed at the meſſage ſent them by Dionyſius, and though reduced to a miſerable ſituation by the plague which had broke out in their city, did not deſpond, but ſent officers to Europe, with conſiderable ſums, to raiſe troops with the utmoſt diligence. Ten galleys were alſo ſent from Carthage to deſtroy all the ſhips that were found in the harbour of Syracuſe. The admiral, according to his orders, entered the harbour in the night, without being diſcerned by the enemy; and having ſunk moſt of the ſhips he found there, returned without the loſs of a man.

22
Motya taken by the Greeks.

All this while the Motyans defended themſelves with incredible vigour; while their enemies, deſirous of revenging the cruelties exerciſed upon their countrymen by the Carthaginians, fought like lions. At laſt the place was taken by ſtorm, and the Greek ſoldiers began a general maſſacre. For ſome time Dionyſius was not able to reſtrain their fury: but at laſt he proclaimed that the Motyans ſhould fly to the Greek temples; which they accordingly did, and a ſtop was put to the ſlaughter; but the ſoldiers took care thoroughly to plunder the town, in which they found a great treaſure.

The following ſpring, Dionyſius invaded the Carthaginian territories, and made an attempt upon Egeſta: but here he was again diſappointed. The Carthaginians were greatly alarmed at his progreſs; but, next year, notwithſtanding a conſiderable loſs ſuſtained in a ſea-fight with Leptines, Himilco their general landed a powerful army at Panormus, ſeized upon Eryx, and then advancing towards Motya, made himſelf maſter of it before Dionyſius could ſend any forces to its relief. He next advanced to Meſſana, which he likewiſe beſieged and took; after which moſt of the Siculi revolted from Dionyſius.

32
Greeks defeated at ſea by the Carthaginians.

Notwithſtanding this defection, Dionyſius, finding his forces ſtill amount to 30,000 foot and 3000 horſe, advanced againſt the enemy. At the ſame time Leptines was ſent with the Syracuſan fleet againſt that of the Carthaginians, but with poſitive orders not to break the line of battle upon any account whatever. But, notwithſtanding theſe orders, he thought proper to divide his fleet, and the conſequence of this was a total defeat; above 100 of the Syracuſan galleys being ſunk or taken, and 20,000 of their men killed in the battle or in the purſuit. Dionyſius, diſheartened by this misfortune, returned with his army to Syracuſe, being afraid that the Carthaginian fleet might become maſters of that city, if he ſhould advance to fight the land army. Himilco did not fail immediately to inveſt the capital; and had certainly become maſter of it, and conſequently of the whole iſland, had not a moſt malignant peſtilence obliged him to deſiſt from all further operations. This dreadful malady made great havock among his forces both by ſea and land; and, to complete

24
Syracuſe beſieged by the Carthaginians.

plete his misfortunes, Dionyſius attacked him unexpectedly, totally ruined his fleet, and made himſelf maſter of his camp.

25
Himilco obliged to return.

Himilco, finding himſelf altogether unable to ſuſtain another attack, was obliged to come to a private agreement with Dionyſius; who for 300 talents conſented to let him eſcape to Africa with the ſhattered remains of his fleet and army. The unfortunate general arrived at Carthage, clad in mean and ſordid attire, where he was met by a great number of people bewailing their ſad and inauſpicious fortune. Himilco joined them in their lamentations; and, being unable to ſurvive his misfortunes, put an end to his own life. He had left Mago in Sicily, to take care of the Carthaginian intereſts in the beſt manner he could. In order to this, Mago treated all the Sicilians ſubject to Carthage with the greateſt humanity; and, having received a conſiderable number of ſoldiers from Africa, he at laſt formed an army with which he ventured a battle; in this he was defeated, and driven out of the field, with the loſs of 800 men; which obliged him to deſiſt from farther attempts of that nature.

26
Another invaſion of Sicily.

Notwithſtanding all theſe terrible diſaſters, the Carthaginians could not forbear making new attempts upon the iſland of Sicily; and about the year before Chriſt 392, Mago landed in it with an army of 80,000 men. This attempt, however, was attended with no better ſucceſs than before: Dionyſius found means to reduce him to ſuch ſtraits for want of proviſions, that he was obliged to ſue for peace. This continued for nine years, at the end of which the war was renewed with various ſucceſs. It continued with little interruption till the year before Chriſt 376, when the Syracuſan ſtate being rent by civil civil diſſenſions, the Carthaginians thought it a proper time to exert themſelves, in order to become maſters of the whole iſland. They fitted out a great fleet, and entered into alliance with Icetas, tyrant of Leontini, who pretended to have taken Syracuſe under his protection. By this treaty, the two powers engaged to aſſiſt each other, in order to expel Dionyſius II. after which they were to divide the iſland between them. The Syracuſans applied for ſuccours to the Corinthians: and they readily ſent them a body of troops under the command of Timoleon an experienced general. By a ſtratagem, he got his forces landed at Taurominium. The whole of them did not exceed 1200 in number: yet with theſe he marched againſt Icetas, who was at the head of 5000 men: his army he ſurpriſed at ſupper, put 300 of them to the ſword, and took 600 priſoners. He then marched to Syracuſe, and broke into one part of the town before the enemy had any notice of his approach: here he took poſt, and defended himſelf with ſuch reſolution, that he could not be diſlodged by the united power of Icetas and the Carthaginians.

27
Syracuſans aſſiſted by the Corinthians.

28
Fooliſh conduct of the Carthaginian admiral.

In this place he remained for ſome time, in expectation of a reinforcement from Corinth; till the arrival of which he did not judge it practicable to extend his conqueſts.—The Carthaginians, being appriſed that the Corinthian ſuccours were detained by tempeſtuous weather at Thurium, poſted a ſtrong ſquadron, under Hanno their admiral, to intercept them in their paſſage to Sicily. But that commander, not imagining the Corinthians would attempt a paſſage to Sicily in ſuch a ſtormy ſeaſon, left his ſtation at Thurium, and ordering his ſeamen to crown themſelves with garlands, and adorn their veſſels with bucklers both of the Greek and Carthaginian form, ſailed to Syracuſe in a triumphant manner. Upon his arrival there, he gave the troops in the citadel to underſtand that he had taken the ſuccours Timoleon expected, thinking by this means to intimidate them to ſurrender. But, while he thus trifled away his time, the Corinthians marched with great expedition to Rhegium, and, taking the advantage of a gentle breeze, were eaſily wafted over into Sicily. Mago, the Carthaginian general, was no ſooner informed of the arrival of this reinforcement, than he was ſtruck with terror, though the whole Corinthian army did not exceed 4000 men; and ſoon after, fearing a revolt of his mercenaries, he weighed anchor, in ſpite of all the remonſtrances of Icetas, and ſet ſail for Africa. Here he no ſooner arrived, than, overcome with grief and ſhame for his unparalleled cowardice, he laid violent hands on himſelf. His body was hung upon a gallows or croſs, in order to deter ſucceeding generals from forfeiting their honour in ſo flagrant a manner.

29
Cowardice of Mago.

30
Exploits of Timoleon.

After the flight of Mago, Timoleon carried all before him. He obliged Icetas to renounce his alliance with the ſtate of Carthage, and even depoſed him, and continued his military preparations with the greateſt vigour. On the other hand, the Carthaginians prepared for the enſuing campaign with the greateſt alacrity. An army of 70,000 men was ſent over, with a fleet of 200 ſhips of war, and 1000 tranſports laden with warlike engines, armed chariots, horſes, and all other ſorts of proviſions. This immenſe multitude, however, was overthrown on the banks of the Crimeſus by Timoleon: 10,000 were left dead on the field of battle; and of theſe above 3000 were native Carthaginians of the beſt families in the city. Above 15,000 were taken priſoners; all their baggage and proviſions, with 200 chariots, 1000 coats of mail, and 10,000 ſhields, fell into Timoleon's hands. The ſpoils, which conſiſted chiefly of gold and ſilver, was ſo immenſe, that the whole Sicilian army was three days in collecting it and ſtripping the ſlain. After this ſignal victory, he left his mercenary forces upon the frontiers of the enemy, to plunder and ravage the country; while he himſelf returned to Syracuſe with the reſt of his army, where he was received with the greateſt demonſtrations of joy. Soon after, Icates, grown weary of his private ſtation, concluded a new peace with the Carthaginians; and, having aſſembled an army, ventured an engagement with Timoleon: but in this he was utterly defeated; and himſelf, with Eupolemus his ſon, and Euthymus, general of his horſe, were brought bound to Timoleon by their own ſoldiers. The two firſt were immediately executed as tyrants and traitors, and the laſt murdered in cold blood; Icetas's wives and daughters were likewiſe cruelly put to death after a public trial. In a ſhort time after, Mamercus, another of the Carthaginian confederates, was overthrown by Timoleon, with the loſs of 2000 men. Theſe misfortunes induced the Carthaginians to conclude a peace on the following terms: That all the Greek cities ſhould be ſet free; that the river Halycus ſhould be the boundary between the territories of both parties; that the natives of the cities ſubject to the

31
Peace concluded.

Carthaginians ſhould be allowed to withdraw, if they pleaſed, to Syracuſe, or its dependencies, with their families and effects; and laſtly, that Carthage ſhould not, for the future, give any aſſiſtance to the remaining tyrants againſt Syracuſe.

32 War renewed.

33 Agathocles raiſes himſelf to the throne of Syracuſe.

About 316 years before Chriſt, we find the Carthaginians engaged in another bloody war with the Sicilians, on the following occaſion; Soſiſtratus, who had uſurped the ſupreme authority at Syracuſe, having been forced by Agathocles to raiſe the ſiege of Rhegium, returned with his ſhattered troops to Sicily. But ſoon after this unſucceſsful expedition he was obliged to abdicate the ſovereignty and quit Syracuſe. With him were expelled above 600 of the principal citizens, who were ſuſpected of having formed a deſign to overturn the plan of government which then prevailed in the city. As Soſiſtratus and the exiles thought themſelves ill treated, they had recourſe to the Carthaginians, who readily eſpouſed their cauſe. Hereupon the Syracuſans, having recalled Agathocles, who had before been baniſhed by Soſiſtratus, appointed him commander in chief of all their forces, principally on account of the known averſion he bore that tyrant. The war, however, did not then continue long; for Soſiſtratus and the exiles were quickly received again into the city, and peace was concluded with Carthage: The people of Syracuſe, however, finding that Agathocles wanted to make himſelf abſolute, exacted an oath from him, that he would do nothing to the prejudice of the democracy. But, notwithſtanding this oath, Agathocles purſued his purpoſe, and by a general maſſacre of the principal citizens of Syracuſe, raiſed himſelf to the throne. For ſome time he was obliged to keep the peace he had concluded with Carthage; but at laſt, finding his authority eſtabliſhed, and that his ſubjects were ready to ſecond his ambitious deſigns, he paid no regard to his treaties, but immediately made war on the neighbouring ſtates, which he had expreſsly agreed not to do, and then carried his arms into the very heart of the iſland. In theſe expeditions he was attended with ſuch ſucceſs, that in two years time he brought into ſubjection all the Greek part of Sicily. This being accompliſhed, he committed great devaſtations in the Carthaginian territories, their general Hamilcar not offering to give him the leaſt diſturbance. This perfidious conduct greatly incenſed the people of thoſe diſtricts againſt Hamilcar, whom they accuſed before the ſenate. He died, however, in Sicily; and Hamilcar the ſon of Giſco was appointed to ſucceed him in the command of the forces. The laſt place that held out againſt Agathocles was Meſſana, whether all the Syracuſan exiles had retired. Paſiphilus, Agathocles's general, found means to cajole the inhabitants into a treaty: which Agathocles, according to cuſtom, paid no regard to, but, as ſoon as he was in poſſeſſion of the town, cut off all thoſe who had oppoſed his government. For, as he intended to proſecute the war with the utmoſt vigour againſt Carthage, he thought it a point of good policy to deſtroy as many of his Sicilian enemies as poſſible.

34 Defeated by the Carthaginians, and beſieged in Syracuſe.

The Carthaginians in the mean time having landed a powerful army in Sicily, an engagement ſoon enſued in which Agathocles was defeated with the loſs of 7000 men. After this defeat he was obliged to ſhut himſelf up in Syracuſe, which the Carthaginians immediately inveſted, and moſt of the Greek ſtates in the iſland ſubmitted to them.

35 He invades Africa.

Agathocles, ſeeing himſelf ſtripped of almoſt all his dominions, and his capital itſelf in danger of falling into the hands of the enemy, formed a deſign, which, were it not atteſted by writers of undoubted authority, would ſeem abſolutely incredible. This was no leſs than to transfer the war into Africa, and lay ſiege to the enemy's capital, at a time when he himſelf was beſieged, and only one city left to him in all Sicily. Before he departed, however, he made all the neceſſary preparations for the defence of the place, and appointed his brother Antandrus governor of it. He alſo gave permiſſion to all who were not willing to ſtand the fatigues of a ſiege to retire out of the city. Many of the principal citizens, Juſtin ſays 1600, accepted of this offer: but they were no ſooner got out of the place, than they were cut off by parties poſted on the road for that purpoſe. Having ſeized upon their eſtates, Agathocles raiſed a conſiderable ſum, which was intended in ſome meaſure to defray the expence of the expedition: however, he carried with him only 50 talents to ſupply his preſent wants, being well aſſured that he ſhould find in the enemy's country whatever was neceſſary for his ſubſiſtence. As the Carthaginians had a much ſuperior fleet, they for ſome time kept the mouth of the harbour blocked up; but at laſt a fair opportunity offered; and Agathocles hoiſting ſail, by the activity of his rowers ſoon got clear both of the port and city of Syracuſe. The Carthaginians purſued him with all poſſible expedition; but, notwithſtanding their utmoſt efforts, Agathocles got his troops landed with very little oppoſition.

36 He burns his fleet.

Soon after his forces were landed, Agathocles burnt his fleet, prabably that his ſoldiers might behave with the greater reſolution, as they ſaw no poſſibility of flying from their danger. He firſt advanced to a place called the Great City. This, after a feeble reſiſtance, he took and plundered. From hence he marched to Tunis, which ſurrendered on the firſt ſummons; and Agathocles levelled both places with the ground.

37 Carthaginians defeated.

38 Their method of appeaſing their deities.

The Carthaginians were at firſt thrown into the greateſt conſternation; but, ſoon recovering themſelves, the citizens took up arms with ſo much alacrity, that in a few days they had on foot an army of 40,000 foot and 1000 horſe, with 2000 armed chariots. The command of this army they entruſted to Hanno and Bomilcar, two generals between whom there ſubſiſted a great animoſity. This occaſioned the defeat of their whole army, with the loſs of their camp, though all the forces of Agathocles did not exceed 14,000 in number. Among other rich ſpoils the conqueror found many chariots of curious workmanſhip, which carried 20,000 pair of fetters and manacles that the enemy had provided for the Sicilian priſoners. After this defeat, the Carthaginians, ſuppoſing themſelves to have fallen under the diſpleaſure of their deities on account of their neglecting to ſacrifice children of noble families to them, reſolved to expiate this guilt. Accordingly 200 children of the firſt rank were ſacrificed to their bloody gods, beſides 300 other perſons who voluntarily offered themſelves to pacify the wrath of theſe deities.

After theſe expiations, Hamilcar was recalled from Sicily.

39
Hamilcar makes an aſſault on Syracuſe.

Sicily. When the meſſengers arrived, Hamilcar commanded them not once to mention the victory of Agathocles; but, on the contrary, to give out among the troops that he had been entirely defeated, his forces all cut off, and his fleet deſtroyed by the Carthaginians. This threw the Syracuſans into the utmoſt deſpair; however, one Eurymnon, an Etolian, prevailed upon Antandrus not to conſent to a capitulation, but to ſtand a general aſſault. Hamilcar being informed of this, prepared his battering engines, and made all the neceſſary preparations to ſtorm the town without delay. But while matters remained in this ſituation, a galley, which Agathocles had cauſed to be built immediately after the battle, got into the harbour of Syracuſe, and acquainted the inhabitants with the certainty of Agathocles's victory. Hamilcar, obſerving that the garriſon flocked down to the port on this occaſion, and expecting to find the walls unguarded, ordered his ſoldiers to erect ſcaling-ladders, and begin the intended aſſault. The enemy having left the ramparts quite expoſed, the Carthaginians mounted them without being diſcerned, and had almoſt poſſeſſed themſelves of an entire part lying between two towers, when the patrol diſcovered them. Upon this, a warm diſpute enſued; but at laſt the Carthaginians were repulſed with loſs. Hamilcar, therefore, finding it in vain to continue the ſiege after ſuch glad tidings had reſtored life and ſoul to the Syracuſans, drew off his forces, and ſent a detachment of 5000 men to reinforce the troops in Africa. He ſtill entertained hopes, however, that he might oblige Agathocles to quit Africa, and return to the defence of his own dominions. He ſpent ſome time in making himſelf maſter of ſuch cities as ſided with the Syracuſans; and, after having brought all their allies under ſubjection, returned again to Syracuſe, hoping to ſurpriſe it by an attack in the night-time. But being attacked while advancing through narrow paſſes, where his numerous army had not room to act, he was defeated with great ſlaughter, and himſelf taken priſoner, carried into Syracuſe, and put to death.

40
He raiſes the ſiege.

41
Is defeated, and taken priſoner, and put to death

42
Agrigentines attempt the ſovereignty of Sicily.

In the mean time the Agrigentines, finding that the Carthaginians and Syracuſans had greatly weakened each other by this war, thought it a proper opportunity to attempt the ſovereignty of the whole iſland. They therefore commenced a war againſt both parties; and proſecuted it with ſuch ſucceſs, that in a ſhort time they wreſted many places of note both out of the hands of the Syracuſans and Carthaginians.

43
Succeſs of Agathocles in Africa.

In Africa the tyrant carried every thing before him He reduced moſt of the places of any note in the terreritory of Carthage; and hearing that Elymas king of Libya had declared againſt him, he immediately entered Libya Superior, and in a great battle overthrew that prince, putting to the ſword a good part of his troops, and the general who commanded them; after which he advanced againſt the Carthaginians with ſuch expedition, that he ſurpriſed and defeated them with the loſs of 2000 killed, and a great number taken priſoners. He next prepared for the ſiege of Carthage itſelf; and in order thereto advanced to a poſt within five miles of that city. On the other hand, notwithſtanding the great loſſes they had already ſuſtained, the Carthaginians, with a powerful army, encamped between him and their capital. In this ſituation Agathocles received advice of the defeat of the Carthaginian forces before Syracuſe, and the head of Hamilcar their general. Upon this he immediately rode up to the enemy's camp, and ſhowing them the head, gave them an account of the total deſtruction of their army before Syracuſe. This threw them into ſuch conſternation, that in all human probability Agathocles would have made himſelf maſter of Carthage, had not an unexpected mutiny ariſen in his camp, which gave the Carthaginians an opportunity of recovering from their terror.

44
He makes an alliance with Ophellas;

The year following an engagement happened, in which neither party gained any great advantage: but ſoon after, the tyrant, notwithſtanding all his victories, found himſelf unable to carry on the war alone; and therefore endeavoured to gain over to his intereſt Ophellas, one of the captains of Alexander the Great. In this he perfectly ſucceeded; and to ſuccour his new ally the more effectually, Ophellas ſent to Athens for a body of troops. Having finiſhed his military preparations, Ophellas found his army to conſiſt of 10,000 foot and 600 horſe, all regular troops, beſides 100 chariots, and a body of 10,000 men, attended by their wives and children, as though he had been going to plant a new colony. At the head of theſe forces he continued his march towards Agathocles for 18 days; and then encamped at Automale. a city about 3000 ſtadia diſtant from the capital of his dominions. From thence he advanced through the Regio Syrtica; but found himſelf reduced to ſuch extremities, that his army was in danger of periſhing for want of bread, water, and other proviſions. They were alſo greatly annoyed by ſerpents and wild beaſts, with which that deſert region abounded. The ſerpents made the greateſt havock among the troops; for, being of the ſame colour with the earth, and extremely venomous, many ſoldiers, who trod upon them without ſeeing them, were ſtung to death. At laſt, after a very fatiguing march of two months, he appoached Agathocles, and encamped at a ſmall diſtance from him, to the no ſmall terror of the Carthaginians, who apprehended the moſt fatal conſequences from this junction. Agathocles at firſt careſſed him, and adviſed him to take all poſſible care of his troops that had undergone ſo many fatigues; but ſoon after cut him off by treachery, and then by fair words and promiſes perſuaded his troops to ſerve under himſelf.

45
whom he treacherouſly murders.

Agathocles, now finding himſelf at the head of a numerous army, aſſumed the title of King of Africa, intending ſoon to complete his conqueſts by the reduction of Carthage. He began with the ſiege of Utica, which was taken by aſſault. After this he marched againſt Hippo Diarrhytus, the Biſerta of the moderns, which was alſo taken by ſtorm; and after this moſt of the people bordering upon the ſea coaſts, and even thoſe who inhabited the inland parts of the country, ſubmitted to him. But in the midſt of this career of ſucceſs, the Sicilians formed an aſſociation in favour of liberty; which obliged the tyrant to return home, leaving his ſon Archagathus to carry on the war in Africa.

46
Is obliged to return home.

47
Succeſs of Archagathus.

Archagathus, after his father's departure, greatly extended the African conqueſts. He ſent Eumachus at the head of large detachment to invade ſome of the neighbouring provinces, while he himſelf, with the greateſt part of his army, obſerved the motions of the Carthaginians. Eumachus falling into Numidia, firſt took the great city of Tocas, and conquered ſeveral of the Numidian cantons. Afterwards he beſieged and took Phellina; which was attended with the ſubmiſſion of the Aſphodelodians, a nation, according to Diodorus, as black as the Ethiopians. He then reduced ſeveral cities; and being at laſt elated with ſuch a run of good fortune, reſolved to penetrate into the more remote parts of Africa. Here he at firſt meet with ſucceſs; but hearing that the barbarous nations were advancing in a formidable body to give him battle, he abandoned his conqueſts, and retreated with the utmoſt precipation towards the ſea coaſts, after having loſt abundance of men.

43 He is reduced to the utmoſt diſtreſs.

This unfortunate expedition made a great alteration for the worſe in the affairs of Archagathus. The Carthaginians being informed of Eumachus's bad ſucceſs, reſolved to exert themſelves in an extraordinary manner to repair their former loſſes. They divided their forces into three bodies: one of theſe they ſent to the ſea coaſts, to keep the towns there in awe; another they diſpatched into the Mediterranean parts, to preſerve the allegiance of the inhabitants there; and the laſt body they ordered to the Upper Africa, to ſupport their confederates in that country. Archagathus, being appriſed of the motions of the Carthaginians, divided his forces likewiſe into three bodies. One of theſe he ſent to obſerve the Carthaginian troops on the ſea coaſts, with orders to advance afterwards into the Upper Africa; another under the command of Æſchrion, one of his generals, he poſted at a proper diſtance in the heart of the country, to have an eye both on the enemy there and the barbarous nations; and with the laſt, which he led in perſon, he kept nearer Carthage, preſerving a communication with the other two, in order to ſend them ſuccours, or recal them, as the exigency of affairs ſhould require.—The Carthaginian troops ſent into the heart of the country, were commanded by Hanno, a general of great experience, who being informed of the approach of Æſchrion, laid an ambuſcade for him, into which he was drawn, and cut off with 4000 foot and 200 horſe. Himilco, who commanded the Carthaginian forces in upper Africa, having advice of Eumachus's march, immediately advanced againſt him. An engagement enſued, in which the Greeks were almoſt totally cut off, or periſhed with thriſt after the battle, out of 8000 foot only 30, and of 800 horſe only 40, having the good fortune to make their eſcape.

Archagathus receiving the melancholy news of theſe two defeats, immediately called in the detachments he had ſent out to haraſs the enemy, which would otherwiſe have been inſtantly cut off. He was, however, in a ſhort time hemmed in on all ſides, in ſuch a manner as to be reduced to the laſt extremity for want of proviſions, and ready every moment to be ſwallowed up by the numerous forces which ſurrounded him. In this deplorable ſituation Agathocles received an expreſs from Archagathus, acquainting him of the loſſes he had ſuſtained, and the ſcarcity of proviſions he laboured under. Upon this the tyrant, leaving the care of the Sicilian war to one Leptines, by a ſtratagem got 18 Etruſcan ſhips that came to his aſſiſtance out of the harbour; and then engaging the Carthaginian ſquadron which lay in its neighbourhood, took five of their ſhips, and made all their men priſoners. By this means he became maſter of the port, and ſecured a paſſage into it for the merchants of all nations, which ſoon reſtored plenty to that city, where the famine before had begun to make great havock. Supplying himſelf, therefore, with a ſufficient quantity of neceſſaries for the voyage he was going to undertake, he immediately ſet ſail for Africa.

49 Agathocles arrives in Africa.

Upon his arrival in this country, Agathocles reviewed his forces, and found them to conſiſt of 6000 Greeks, as many Samnites, Celtes, and Etruſcans; beſides 10,000 Africans, and 1500 horſe. As he found his troops almoſt in a ſtate of deſpair, he thought this a proper time for offering the enemy battle. The Carthaginians, however, did not think proper to accept the challenge; eſpecially as, by keeping cloſe in their camp, where they had plenty of every thing, they could ſtarve the Greeks to a ſurrender without ſtriking a ſtroke. Upon this Agathocles attacked the Carthaginian camp with great bravery, made a conſiderable impreſſion upon it, and might perhaps have carried it, had not his mercenaries deſerted him almoſt at the firſt onſet. By this piece of cowardice he was forced to retire with precipitation to his camp, whether the Carthaginians purſued him very cloſely, doing great execution in the purſuit.

50 Attacks the enemy without ſucceſs.

51 Diſaſter in the Carthaginian camp.

The next night, the Carthaginians ſacrificed all the priſoners of diſtinction as a grateful acknowledgment to the gods for the victory they had gained. While they were employed in this inhuman work, the wind, ſuddenly riſing, carried the flames to the ſacred tabernacle near the altar, which was entirely conſumed, as well as the general's tent, and thoſe of the principal officers adjoining to it. A dreadful alarm took place through the whole camp, which was heightened by the great progreſs the fire made. For the ſoldiers tents conſiſting of very combuſtible materials, and the wind blowing in a moſt violent manner, the whole camp was almoſt entirely reduced to aſhes; and many of the ſoldiers, endeavouring to carry off their arms, and the rich baggage of their officers, periſhed in the flames. Some of thoſe who made their eſcape met with a fate equally unhappy: For, after Agathocles had received the laſt blow, the Africans deſerted him, and were in that inſtant coming over in a body to the Carthaginians. Theſe, the perſons who were flying from the flames took to be the whole Syracuſan army advancing in order of battle to attack their camp. Upon this a dreadful confuſion enſued. Some took to their heels; others fell down in heaps one upon another; and others engaged their comrades, miſtaking them for the enemy. Five thouſand men loſt their lives in this tumult, and the reſt thought proper to take refuge within the walls of Carthage; nor could the appearance of daylight, for ſome time, diſſipate their terrible apprehenſions. In the mean time the African deſerters, obſerving the great confuſion the Carthaginians were in, and not knowing the meaning of it, were ſo terrified, that they thought proper to return to the place from whence they came. The Syracuſans, ſeeing a body of troops advancing towards them in good order, concluded that the enemy were

52 Another in that of Agathocles.

were marching to attack them, and therefore immediately cried out, "To arms," The flames aſcending out of the Carthaginian camp into the air, and the lamentable outcries proceeding from thence, confirmed them in this opinion, and greatly heightened their confuſion. The conſequence was much the ſame as in the Carthaginian camp; for coming to blows with one another inſtead of the enemy, they ſcarce recovered their ſenſes upon the return of light, and the inteſtine fray was ſo bloody that it coſt Agathocles 4000 men.

53
He eſcapes privately.

The laſt diſaſter ſo diſheartened the tyrant, that he immediately ſet about contriving means for making his eſcape privately; and this he at laſt, though with great difficulty, effected. After his departure, his two ſons were immediately put to death by the ſoldiers, who, chooſing a leader from among themſelves, made peace with the Carthaginians upon the following conditions: 1. That the Greeks ſhould deliver up all the places they held in Africa, receiving from them 300 talents: 2. That ſuch of them as were willing to ſerve in the Carthaginian army ſhould be kindly treated, and receive the uſual pay; and 3. That the reſt ſhould be tranſported to Sicily, and have the city of Selinus for their habitation.

54
Cauſes of the firſt Punic war.

From this time, to that of their firſt war with the Romans, we find nothing remarkable in the hiſtory of the Carthaginians. The firſt Punic war, as it is commonly called, happened about 256 years before Chriſt. At that time the Carthaginians were poſſeſſed of extenſive dominions in Africa; they had made conſiderable progreſs in Spain; were maſters of Sardinia, Corſica, and all the iſlands on the coaſt of Italy; and had extended their conqueſts to a great part of Sicily. The occaſion of the firſt rupture between the two republics was as follows: The Mamertines being vanquiſhed in battle, and reduced to great ſtraits by Hiero king of Syracuſe, had reſolved to deliver up Meſſina, the only city they now poſſeſſed, to that prince, with whoſe mild government and ſtrict probity they were well acquainted. Accordingly, Hiero was advancing at the head of his troops to take poſſeſſion of the city, when Hannibal, who at that time commanded the Carthaginian army in Sicily, prevented him by a ſtratagem. He came to meet Hiero, as it were to congratulate him on his victory; and amuſed him, while ſome of the Carthaginian troops filed off towards Meſſina. Hereupon the Mamertines, ſeeing their city ſupported by a new reinforcement, were divided into ſeveral opinions. Some were for accepting the protection of Carthage; others were for ſurrendering to the king of Syracuſe; but the greater part were for calling in the Romans to their aſſiſtance. Deputies were accordingly diſpatched to Rome, offering the poſſeſſion of the city to the Romans, and in the moſt moving terms imploring protection. This, after ſome debate, was agreed to; and the conſul Appius Claudius received orders to attempt a paſſage to Sicily at the head of a powerful army. Being obliged to ſtay ſome time at Rome, however, one Caius Claudius, a perſon of great intrepidity and reſolution, was diſpatched with a few veſſels to Rhegium. On his arrival there, he obſerved the Carthaginian ſquadron to be ſo much ſuperior to his own, that he thought it would be little better than madneſs to attempt at that time to tranſport forces to Sicily. He croſſed the ſtraits, however, and had a conference with the Mamertines, in which he prevailed upon them all to accept of the protection of Rome; and on this he made the neceſſary preparations for tranſporting his forces. The Carthaginians, being informed of the reſolution of the Romans, ſent a ſtrong ſquadron of galleys under the command of Hanno to intercept the Roman fleet; and accordingly the Carthaginian admiral, coming up with them near the coaſt of Sicily, attacked them with great fury. During the engagement, a violent ſtorm aroſe, which daſhed many of the Roman veſſels againſt the rocks, and did a vaſt deal of damage to their ſquadron; by which means Claudius was forced to retire to Rhegium, and this he accompliſhed with great difficulty. Hanno reſtored all the veſſels he had taken; but ordered the deputies ſent with them to expoſtulate with the Roman general upon the infraction of the treaties ſubſiſting between the two republics. This expoſtulation, however juſt, produced an open rupture: Claudius ſoon after poſſeſſing himſelf of Meſſina.

55
Hanno intercepts the Roman fleet.

56
Carthaginians and Syracuſans defeated by the Romans.

Such was the beginning of the firſt Punic war, which is ſaid to have laſted 24 years. The firſt year, the Carthaginians and Syracuſans laid ſiege to Meſſina; but not acting in concert as they ought to have done, were overthrown by the conſul Appius Claudius; and this defeat ſo much diſguſted Hiero with the Carthaginians, that he ſoon after concluded an alliance with the Romans. After this treaty, having no enemy to contend with but the Carthaginians, the Romans made themſelves maſters of all the cities on the weſtern coaſt of Sicily, and at the end of the campaign carried back moſt of their troops with them to take up their winter-quarters in Italy.

57
Agrigentum taken by the Romans.

The ſecond year, Hanno the Carthaginian general fixed his principal magazine at Agrigentum. This place was very ſtrong by nature, had been rendered almoſt impregnable by the new fortifications raiſed by the Carthaginians during the preceding winter, and was defended by a numerous garriſon commanded by one Hannibal, a general of great experience in war. For five months the Romans attempted to reduce the place by famine, and had actually brought the inhabitants to great diſtreſs, when a Carthaginian army of 50,000 foot, 6000 horſe, and 60 elephants, landed at Lilybæum, and from thence marched to Heraclea, within 20 miles of Agrigentum. There the general received a deputation from ſome of the inhabitants of Erbeſſa, where the Romans had their magazines, offering to put the town into his hands. It was accordingly delivered up; and by this means the Romans became ſo much diſtreſſed, that they had certainly been obliged to abandon their enterpriſe, had not Hiero ſupplied them with proviſions. But all the aſſiſtance he was able to give could not long have ſupported them, as their army was ſo much weakened by diſorders occaſioned by famine, that, out of 100,000 men, of whom it originally conſiſted, ſcarce a fourth part remained fit for ſervice, and could no longer ſubſiſt on ſuch parſimonious ſupplies. But in the mean time Hannibal acquainted Hanno that the city was reduced to the utmoſt diſtreſs; upon which he reſolved to venture an engagement, which he had before declined. In this the Romans were victorious, and the city ſurrendered at diſcretion, though Hannibal with the greateſt part of the garriſon made their eſcape. This ended the campaign; and the Carthaginians being greatly chagrined at their bad ſucceſs, fined Hanno of an immenſe ſum of money, and deprived him of his command, appointing Hamilcar to ſucceed him in the command of the land army, and Hannibal in that of the fleet.

58
They build a fleet,

The third year, Hannibal received orders to ravage the coaſt of Italy; but the Romans had taken care to poſt detachments in ſuch places as were moſt proper to prevent his landing, ſo that the Carthaginian found it impoſſible to execute his orders. At the ſame time, the Romans, perceiving the advantages of being maſters of the ſea, ſet about building 120 galleys. While this was doing, they made themſelves maſters of moſt of the inland cities, but the Carthaginians reduced or kept ſteady in their intereſt moſt of the maritime ones; ſo that both parties were equally ſucceſsful during this campaign.

The fourth year, Hannibal by a ſtratagem made himſelf maſter of 17 Roman galleys; after which he committed great ravages on the coaſt of Italy, whither he had advanced to take a view of the Roman fleet. But he was afterwards attacked in his turn, loſt the greateſt part of his ſhips, and with great difficulty made his own eſcape. Soon after he was totally defeated by the conſul Duillius, with the loſs of 80 ſhips taken, 13 ſunk, 7000 men killed, and as many taken priſoners. After this victory Duillius landed in Sicily, put himſelf at the head of the land forces, relieved Segeſta, beſieged by Hamilcar, and made himſelf maſter of Macella, though defended by a numerous garriſon.

59
and defeat the Carthaginians at ſea.

60
Sicilians defeated by the Carthaginians.

The fifth year a difference aroſe between the Romans and their Sicilian allies, which came to ſuch a height, that they encamped ſeparately. Of this Hamilcar availed himſelf, and attacking the Sicilians in their entrenchments, put 4000 of them to the ſword. He then drove the Romans from their poſts, took ſeveral cities from them, and overran the greateſt part of the country. In the mean time, Hannibal, after his defeat, ſailed with the ſhattered remains of his fleet to Carthage: but, in order to ſecure himſelf from puniſhment, he ſent one of his friends with all ſpeed, before the event of the battle was known there, to acquaint the ſenate, that the Romans had put to ſea with a good number of heavy ill-built veſſels, each of them carrying ſome machine, the uſe of which the Carthaginians did not underſtand; and aſked whether it was the opinion of the ſenate that Hannibal ſhould attack them? Theſe machines were the *corvi*, which were then newly invented, and by means of which, chiefly, Duillius had gained the victory. The ſenate were unanimous in their opinion that the Romans ſhould be attacked; upon which the meſſenger acquainted them with the unfortunate event of the battle. As the ſenators had already declared themſelves for the engagement, they ſpared their general's life, and, according to Polybius, even continued him in the command of the fleet. In a ſhort time, being reinforced by a good number of galleys, and attended by ſome officers of great merit, he ſailed for the coaſt of Sardinia. He had not been long here, before he was ſurpriſed by the Romans, who carried off many of his ſhips, and took great numbers of his men priſoners. This ſo incenſed the reſt, that they ſeized their unfortunate admiral, and crucified him; but who was his immediate ſucceſſor does not appear.

61
Corſica and Sardinia reduced by the Romans.

The ſixth year, the Romans made themſelves maſters of the iſlands of Corſica and Sardinia. Hanno, who commanded the Carthaginian forces in the latter, defended himſelf at a city called Olbia with incredible bravery; but being at laſt killed in one of the attacks, the place was ſurrendered, and the Romans ſoon became maſters of the whole iſland.

62
The Roman army in great danger.

The ſeventh year, the Romans took the town of Myteſtratum, in Sicily, from whence they marched towards Camarina, but in their way were ſurrounded in a deep valley, and in the moſt imminent danger of being cut off by the Carthaginian army. In this extremity, a legionary tribune, by name *M. Calpurnius Flamma*, deſired the general to give him 300 choſen men; promiſing, with this ſmall company, to find the enemy ſuch employment as ſhould oblige them to leave a paſſage open for the Roman army. He performed his promiſe with a bravery truly heroic; for, having ſeized, in ſpite of all oppoſition, an eminence, and entrenched himſelf on it, the Carthaginians, jealous of his deſign, flocked from all quarters to drive him from his poſt. But the brave tribune kept their whole army in play, till the conſul, taking advantage of the diverſion, drew his army out of the bad ſituation in which he had imprudently brought it. The legions were no ſooner out of danger, than they haſtened to the relief of their brave companions: but all they could do was to ſave their bodies from the inſults of their enemies; for they found them all dead on the ſpot, except Calpurnius, who lay under a heap of dead bodies all covered with wounds, but ſtill breathing. His wounds were immediately dreſſed, and it fortunately happened that none of them proved mortal; and for this glorious enterpriſe he received a crown of *gramen*. After this the Romans reduced ſeveral cities, and drove the enemy quite out of the territory of the Agrigentines; but were repulſed with great loſs before Lipara.

63
Reſcued by the bravery of a legionary tribune.

64
Carthaginians defeated at ſea by the Romans.

The eighth year, Regulus, who commanded the Roman fleet, obſerving that of the Carthaginians lying along the coaſt in diſorder, ſailed with a ſquadron of ten galleys, to obſerve their number and ſtrength, ordering the reſt of the fleet to follow him with all expedition. But as he drew too near the enemy, he was ſurrounded by a great number of Carthaginian galleys. The Romans fought with their uſual bravery; but being overpowered with numbers, were obliged to yield. The conſul, however, found means to make his eſcape, and joined the reſt of the fleet; and then had his full revenge of the enemy, 18 of their ſhips being taken, and eight ſunk.

65
Regulus invades Africa.

The ninth year, the Romans made preparations for invading Africa. Their fleet for this purpoſe conſiſted of 330 galleys, each of them having on board 120 ſoldiers and 300 rowers. The Carthaginian fleet conſiſted of 360 ſail, and was much better manned than that of the Romans. The two fleets met near Ecnomus, a promontory in Sicily; where, after a bloody engagement, which laſted the greater part of the day, the Carthaginians were entirely defeated, with the loſs of 30 galleys ſunk, and 63 taken with all their men. The Romans loſt only 24 galleys, which were all ſunk.—After this victory, the Romans having refitted their fleet, ſet ſail for the coaſt of Africa with all expedition. The firſt land they got ſight of was Cape Hermea, where the fleet lay at anchor for ſome time waiting till the galleys and tranſports came up. From thence they coaſted along till they arrived before Clupea, a city to the eaſt of Carthage, where they made their firſt deſcent.

66 Carthaginians in great conſternation.

No words can expreſs the conſternation of the Carthaginians on the arrival of the Romans in Africa. The inhabitants of Clupea were ſo terrified, that, according to Zonaras, they abandoned the place, which the Romans immediately took poſſeſſion of. Having left there a ſtrong garriſon to ſecure their ſhipping, and keep the adjacent territory in awe, they moved nearer Carthage, taking a great number of towns; they likewiſe plundered a prodigious number of villages, laid vaſt numbers of noblemen's ſeats in aſhes, and took above 20,000 priſoners. In ſhort, having plundered and ravaged the whole country, almoſt to the gates of Carthage, they returned to Clupea loaded with the immenſe booty they had acquired in the expedition.

67 Succeſs of Regulus.

The tenth year, Regulus puſhed on his conqueſts with great rapidity. To oppoſe his progreſs, Hamilcar was recalled from Sicily, and with him Boſtar and Aſdrubal were joined in command. Hamilcar commanded an army juſt equal to that of Regulus. The other two commanded ſeparate bodies, which were to join him or act apart as occaſion required. But, before they were in a condition to take the field, Regulus, purſuing his conqueſts, arrived on the banks of the *Bagrada*, a river which empties itſelf into the ſea at a ſmall diſtance from Carthage. Here he had a monſtrous ſerpent to contend with, which, according to the accounts of thoſe days, infected the waters of the river, poiſoned the air, and killed all other animals with its breath alone. When the Romans went to draw water, this huge dragon attacked them; and, twiſting itſelf round their bodies, either ſqueezed them to death, or ſwallowed them alive. As its hard and thick ſcales were proof againſt their darts and arrows, they were forced to have recourſe to the baliſtæ, which they made uſe of in ſieges to throw great ſtones, and to beat down the walls of beſieged cities. With theſe they diſcharged ſhowers of huge ſtones againſt this new enemy, and had the good luck with one of them, to break his back-bone; which diſabled him from twiſting and winding his immenſe body, and by that means gave the Romans an opportunity of approaching and diſpatching him with their darts. But his dead body corrupted the air and the water of the river; and ſpread ſo great an infection over the whole country, that the Romans were obliged to decamp. We are told that Regulus ſent to Rome the ſkin of this monſter, which was 120 feet long; and that it was hung up in a temple, where it was preſerved to the time of the Numantine war.

68 He kills a monſtrous ſerpent.

69 Defeats the Carthaginians;

Having paſſed this river, he beſieged *Adis*, or *Adda*, not far from Carthage, which the enemy attempted to relieve; but as they lay encamped among hills and rocks, where their elephants, in which the main ſtrength of their army conſiſted, could be of no uſe, Regulus attacked them in their camp, killed 17,000 of them and took 5000 priſoners, and 18 elephants. Upon the fame of this victory, deputations came from all quarters, inſomuch that the conqueror in a few days became maſter of 80 towns: among which were the city and port of Utica. This increaſed the alarm at Carthage; which was reduced to deſpair, when Regulus laid ſiege to Tunis, a great city about nine miles from the capital. The place was taken in ſight of the Carthaginians, who, from their walls, beheld all the operations of the ſiege, without making the leaſt attempt to relieve it. And to complete their misfortunes, the Numidians, their neighbours, and implacable enemies, entered their territories, committing every where the moſt dreadful devaſtations, which ſoon occaſioned a great ſcarcity of proviſions in the city. The public magazines were ſoon exhauſted: and, as the city was full of ſelfiſh merchants, who took advantage of the public diſtreſs, to ſell proviſions at an exorbitant price, a famine enſued, with all the evils which attend it.

70 and reduces them to the utmoſt deſpair.

71 His propoſals of peace rejected.

In this extremity Regulus advanced to the very gates of Carthage; and, having encamped under the walls, ſent deputies to treat of a peace with the ſenate. The deputies were received with inexpreſſible joy; but the conditions they propoſed were ſuch that the ſenate could not hear them without the greateſt indignation. They were, 1. That the Carthaginians ſhould relinquiſh all claims to Sardinia, Corſica, and Sicily. 2. That they ſhould reſtore to the Romans all the priſoners they had taken from them ſince the beginning of the war. 3. That if they cared to redeem any of their own priſoners, they ſhould pay ſo much a head for them as Rome ſhould judge reaſonable. 4. That they ſhould for ever pay the Romans an annual tribute. 5. That for the future they ſhould fit out but one man of war for their own uſe, and 50 triremes to ſerve in the Roman fleet, at the expence of Carthage, when required by any of the future conſuls. Theſe extravagant demands provoked the ſenators, who loudly and unanimouſly rejected them; the Roman deputies, however, told them that Regulus would not alter a ſingle letter of the propoſals, aad that they muſt either conquer the Romans or obey them.

72 Xanthippus appointed to command the Carthaginian army.

In this extreme diſtreſs, ſome mercenaries arrived from Greece, among whom was a Lacedemonian, by name Xanthippus, a man of great valour and experience in war. This man, having informed himſelf of the circumſtances of the late battle, declared publicly, that their overthrow was more owing to their own miſconduct than to the ſuperiority of the enemy. This diſcourſe being ſpread abroad, came at laſt to the knowledge of the ſenate; and by them, and even by the deſire of the Carthaginian generals themſelves, Xanthippus was appointed commander in chief of their forces. His firſt care was to diſcipline his troops in a proper manner. He taught them how to march, encamp, widen and cloſe their ranks, and rally after the Lacedemonian manner under their proper colours. He then took the field with 12,000 foot, 4000 horſe, and 100 elephants. The Romans were ſurpriſed at the ſudden alteration they obſerved in the enemy's conduct: but Regulus, elated with his laſt ſucceſs, came and encamped at a ſmall diſtance from the Carthaginian army in a vaſt plain, where their elephants

73 The Romans utterly defeated and Regulus taken.

and horſe had room to act. The two armies were parted by a river, which Regulus boldly paſſed, by which means he left no room for a retreat in caſe of any miſfortune. The engagement began with great fury; but ended in the total defeat of the Romans, who, except 2000 that eſcaped to Clupea, were all killed or taken priſoners, and among the latter was Regulus himſelf. The loſs of the Carthaginians ſcarce exceeded 800 men.

74 He is cruelly uſed.

The Carthaginians remained on the field of battle till they had ſtripped the ſlain; and then entered their metropolis, which was almoſt the only place left them, in great triumph. They treated all their priſoners with great humanity, except Regulus; but as for him, he had ſo inſulted them in his proſperity, that they could not forbear ſhowing the higheſt marks of their reſentment. According to Zonaras and others, he was thrown into a dungeon, where he had only ſuſtenance allowed him barely ſufficient to keep him alive. Nay, his cruel maſters, to heighten his other torments, ordered a huge elephant (at the ſight of which animal, it ſeems, he was greatly terrified) to be conſtantly placed near him; which prevented him from enjoying any tranquillity or repoſe.

75 Carthaginians defeated by ſea and land.

The eleventh year of this war, the Carthaginians, elated with their victory over Regulus, began to talk in a very high ſtrain, threatening Italy itſelf with an invaſion. To prevent this, the Romans took care to garriſon all their maritime towns, and fitted out a new fleet. In the mean time, the Carthaginians beſieged Clupea and Utica in vain, being obliged to abandon their enterpriſe, upon hearing that the Romans were equipping a fleet of 350 ſail. The Carthaginians having with incredible expedition refitted their old veſſels, and built a good number of new ones, met the Roman fleet off Cape Hermea. An engagement enſued, in which the Carthaginians were utterly defeated; 104 of their ſhips being ſunk, 30 taken, and 15,000 of their ſoldiers and rowers killed in the action. The Romans purſued their courſe to Clupea, where they were no ſooner landed, than they found themſelves attacked by the Carthaginian army, under the two Hannos, father and ſon. But, as the brave Xanthippus no longer commanded their army, notwithſtanding the Lacedemonian diſcipline he had introduced among them, they were routed at the very firſt onſet, with the loſs of 9000 men, and among them many of their chief lords.

76 Romans obliged to abandon Africa.

77 Their fleet totally deſtroyed by a ſtorm.

Notwithſtanding all their victories, however, the Romans found themſelves now obliged, for want of proviſions, to evacuate both Clupea and Utica, and abandon Africa altogether. Being deſirous of ſignalizing the end of their conſulate by ſome important conqueſt in Sicily, the conſuls ſteered for that iſland, contrary to the advice of their pilots, who repreſented their danger, on account of the ſeaſon being ſo far advanced. Their obſtinacy proved the deſtruction of the whole fleet; for a violent ſtorm ariſing, out of 370 veſſels only 80 eſcaped ſhipwreck, the reſt being ſwallowed up by the ſea, or daſhed againſt the rocks. This was by far the greateſt loſs that Rome had ever ſuſtained; for beſides the ſhips that were caſt away with their crews, a numerous army was deſtroyed, with all the riches of Africa, which had been by Regulus amaſſed and depoſited in Clupea, and were now from thence tranſporting to Rome. The whole coaſt from Pachinum to Camerina was covered with dead bodies and wrecks of ſhips; ſo that hiſtory can ſcarce afford an example of ſuch a dreadful diſaſter.

78 Agrigentum taken and deſtroyed by the Carthaginians.

The twelfth year, the Carthaginians hearing of this miſfortune of the Romans, renewed the war in Sicily with freſh fury, hoping the whole iſland, which was now left defenceleſs, would fall into their hands. Carthalo, a Carthaginian commander, beſieged and took Agrigentum. The town he laid in aſhes, and demoliſhed the walls, obliging the inhabitants to fly to Olympium. Upon the news of this ſucceſs, Aſdrubal was ſent to Sicily with a large reinforcement of troops, and 150 elephants. They likewiſe fitted out a ſquadron, with which they retook the iſland of Corcyra, and marched a ſtrong body of forces into Mauritania and Numidia, to puniſh the people of thoſe countries for ſhowing a diſpoſition to join the Romans. In Sicily the Romans poſſeſſed themſelves of Cephalodium and Panormus, but were obliged by Carthalo to raiſe the ſiege of Drepanum with great loſs.

79 The Romans fit out a new fleet.

80 Which is again deſtroyed.

The 13th year, the Romans ſent out a fleet of 260 galleys, which appeared off Lilybæum in Sicily: but finding this place too ſtrong, they ſteered from thence to the eaſtern coaſt of Africa, where they made ſeveral deſcents, ſurpriſed ſome cities, and plundered ſeveral towns and villages. They arrived ſafe at Panormus, and in a few days ſet ſail for Italy, having a fair wind till they came off Cape Palinurus, where ſo violent a ſtorm overtook them, that 160 of their galleys and a great number of their tranſports were loſt; upon which the Roman ſenate made a decree, that for the future no more than 50 veſſels ſhould be equipped; and that theſe ſhould be employed only in guarding the coaſt of Italy, and tranſporting the troops into Sicily.

81 They fit out another.

82 Carthaginians utterly defeated.

The 14th year, the Romans made themſelves maſters of Himera and Lipara in Sicily; and the Carthaginians conceiving new hopes of conquering that iſland, began to make freſh levies in Gaul and Spain, and to equip a new fleet. But their treaſures being exhauſted, they applied to Ptolemy king of Egypt, intreating him to lend them 2000 talents; but he, being reſolved to ſtand neuter, refuſed to comply with their requeſt; telling them that he could not, without breach of fidelity, aſſiſt one friend againſt another. However, the republic of Carthage making an effort, equipped a fleet of 200 ſail, and raiſed an army of 30,000 men, horſe and foot, and 140 elephants, appointing Aſdrubal commander in chief both of the fleet and army. The Romans, then, finding the great advantages of a fleet, reſolved to equip one, notwithſtanding all former diſaſters; and while the veſſels were building, two conſuls were choſen, men of valour and experience, to ſuperſede the acting ones in Sicily. Metellus, however, one of the former conſuls, being continued with the title of proconſul, found means to draw Aſdrubal into a battle on diſadvantageous terms near Panormus, and then ſallying out upon him, gave him a moſt terrible overthrow. Twenty thouſand of the enemy were killed, and many elephants. An hundred and four elephants were taken with their leaders, and ſent to Rome, where they were hunted and put to death in the circus.

The 15th year the Romans beſieged Lilybæum;

83
Lilybæum beſieged by the Romans.

and the ſiege continued during the reſt of the firſt Punic war, and was the only thing remarkable that happened during that time *. The Carthaginians, on the firſt news of its being beſieged, ſent Regulus with ſome deputies to Rome to treat of a peace; but, inſtead of forwarding the negotiation, he hindered it: and notwithſtanding he knew the torments prepared for him at Carthage, could not be prevailed upon to ſtay at Rome, but returning to his enemies country, was put to a moſt cruel death.

84
They are defeated at ſea by the Carthaginians.

During this ſiege, the Roman fleet under Claudius Pulcher was utterly defeated by Adherbal the Carthaginian admiral. Ninety of the Roman galleys were loſt in the action, 8000 of their men either killed or drowned, and 20,000 taken and ſent priſoners to Carthage; and the Carthaginians gained this ſignal victory without the loſs of a ſingle ſhip, or even a ſingle man.

85
A Roman fleet utterly deſtroyed by a ſtorm.

Another Roman fleet met with a ſtill ſeverer fate. It conſiſted of 120 galleys, 800 tranſports, and was laden with all ſort of military ſtores and proviſions. Every one of theſe veſſels was loſt by a ſtorm, with all they contained, not a ſingle plank being ſaved that could be uſed again; ſo that the Romans found themſelves once more deprived of their whole naval force.

86
Hamilcar Barcas ſent into Sicily.

In the mean time, the Carthaginian ſoldiery having ſhown a diſpoſition to mutiny, the ſenate ſent over Hamilcar Barcas, father of the famous Hannibal, to Sicily. He received a charte blanch from the ſenate to act as he thought proper; and, by his excellent conduct and reſolution, ſhowed himſelf the greateſt general of his age. He defended Eryx, which he had taken by ſurpriſe, with ſuch vigour, that the Romans would never have been able to make themſelves maſters of it, had they not fitted out a new fleet at the expence of private citizens, which, having utterly defeated that of the Carthaginians, Hamilcar, notwithſtanding all his valour, was obliged to yield up the place which he had ſo long and ſo bravely defended.

87
Peace with the Romans.

The following articles of peace were immediately drawn up between the two commanders. 1. The Carthaginians ſhall evacuate all the places which they have in Sicily, and entirely quit that iſland. 2. They ſhall, in 20 years, pay the Romans, at equal payments every year, 2200 talents of ſilver, that is, 437,250l. Sterling. 3. They ſhall reſtore the Roman captives and deſerters without ranſom, and redeem their own priſoners with money. 4. They ſhall not make war upon Hiero king of Syracuſe, or his allies. Theſe articles being agreed to, Hamilcar ſurrendered Eryx upon condition that all his ſoldiers ſhould march out with him, upon his paying for each of them 18 *Roman dinarii*. Hoſtages were given on both ſides, and deputies were ſent to Rome to procure a ratification of the treaty by the ſenate. After the ſenators had thoroughly informed themſelves of the ſtate of affairs, two more articles were added, viz. 1. That 1000 talents ſhould be paid immediately, and the 2200 in the ſpace of 10 years at equal payments. 2. That the Carthaginians ſhould quit all the little iſlands about Italy and Sicily, and never more come near them with ſhips of war, or raiſe mercenaries in thoſe places. Neceſſity obliged Hamilcar to conſent to theſe terms; but he returned to Carthage with a hatred to the Romans which he did not even ſuffer to die with him, but tranſmitted to his ſon the great Hannibal.

88
Cauſes of the war with the mercenaries.

The Carthaginians were no ſooner got out of this bloody and expenſive war, than they found themſelves enaged in another, which was like to have proved fatal to them. It is called by ancient hiſtorians the *Libyan war*, or the *war with the mercenaries*. The principal occaſion of it was, that when Hamilcar returned to Carthage, he found the republic ſo much impoveriſhed, that, far from being able to give theſe troops the largeſſes and rewards promiſed them, it could not pay them their arrears. He had committed the care of tranſporting them to one *Giſco*, who, being an officer of great penetration, as though he had foreſeen what would happen, did not ſhip them off all at once, but in ſmall and ſeparate parties, that thoſe who came firſt might be paid off and ſent home before the arrival of the reſt. The Carthaginians at home, however, did not act with the ſame prudence. As the ſtate was almoſt entirely exhauſted by the late war, and the immenſe ſum of money, in conſequence of the peace, paid to the Romans, they judged it would be a laudable action to ſave ſomething to the public. They did not therefore pay off the mercenaries in proportion as they arrived, thinking it more proper to wait till they all came together, with a view of obtaining ſome remiſſion of their arrears. But, being ſoon made ſenſible of their wrong conduct on this occaſion, by the frequent diſorders theſe barbarians committed in the city, they with ſome difficulty prevailed upon the officers to take up their quarters at Sicca, and canton their troops in that neighbourhood. To induce them to this, however, they gave them a ſum of money for their preſent ſubſiſtence, and promiſed to comply with their pretenſions when the remainder of their troops arrived from Sicily. Here, being wholly immerſed in idleneſs, to which they had long been ſtrangers, a neglect of diſcipline enſued, and of courſe a petulant and licentious ſpirit immediately took place. They were now determined not to acquieſce in receiving their bare pay, but to inſiſt upon the rewards Hamilcar had promiſed them, and even to compel the ſtate of Carthage to comply with their demands by force of arms.

89
Imprudent conduct of Hanno.

The ſenate being informed of the mutinous diſpoſition of the ſoldiery, diſpatched Hanno, one of the ſuffetes, to pacify them. Upon his arrival at Sicca, he expatiated largely upon the poverty of the ſtate, and the heavy taxes with which the citizens of Carthage were loaded; and therefore, inſtead of anſwering their high expectations, he deſired them to be ſatisfied with receiving part of their pay, and remit the remainder to ſerve the preſſing exigencies of the republic. The mercenaries being highly provoked, that neither Hamilcar, nor any other of the principal officers, who commanded them in Sicily, and were the beſt judges of their merit, made their appearance on this occaſion, but only Hanno, a perſon utterly unknown, and above all others utterly diſagreeable to them, immediately had recourſe to arms. Aſſembling therefore in a body, to the number of 20,000, they advanced to Tunis, and immediately encamped before that city.

The Carthaginians, being greatly alarmed at the approach of ſo formidable a body to Tunis, made large conceſſions to the mercenaries, in order to bring them back to their duty; but, far from being ſoftened, they grew more inſolent upon theſe conceſſions, taking them for the effects of fear: and therefore were altogether averſe to thoughts of accommodation. The Carthaginians, making a virtue of neceſſity, ſhowed a diſpoſition to ſatisfy them in all points, and agreed to refer themſelves to the opinion of ſome general in Sicily, which they had all along deſired; leaving the choice of ſuch commander entirely to them. Giſco was accordingly pitched upon to mediate this affair, the mercenaries believing Hamilcar to have been a principal cauſe of the ill treatment they met with, ſince he never appeared among them, and, according to the general opinion, had voluntarily reſigned his commiſſion. Giſco ſoon arrived at Tunis with money to pay the troops; and, after conferring with the officers of the ſeveral nations apart, he harangued them in ſuch a manner, that a treaty was upon the point of being concluded, when Spendius and Mathos, two of the principal mutineers, occaſioned a tumult in every part of the camp. Spendius was by nation a Campanian, who had been a ſlave at Rome, and had fled to the Carthaginians. The apprehenſions he was under of being delivered to his old maſter, by whom he was ſure to be hanged or crucified, prompted him to break off the accommodation. Mathos was an African, and free born; but as he had been active in raiſing the rebellion, and was well acquainted with the implacable diſpoſition of the Carthaginians, he knew that a peace muſt infallibly prove his ruin. He therefore joined with Spendius, and inſinuated to the Africans the danger of concluding a treaty at that juncture, which could not but leave them ſingly expoſed to the rage of the Carthaginians. This ſo incenſed the Africans, who were much more numerous than the troops of any other nation, that they immediately aſſembled in a tumultuous manner. The foreigners ſoon joined them, being inſpired by Spendius with an equal degree of fury. Nothing was now to be heard but the moſt horrid oaths and imprecations againſt Giſco and the Carthaginians. Whoever offered to make any remonſtrance, or lend an ear to temperate counſels, was ſtoned to death by the enraged multitude. Nay, many perſons loſt their lives barely for attempting to ſpeak, before it could be known whether they were in the intereſt of Spendius or the Carthaginians.

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* See *Lilybæum*.

In the midſt of theſe commotions, Giſco behaved with great firmneſs and intrepidity. He left no methods untried to ſoften the officers and calm the minds of the ſoldiery; but the torrent of ſedition was now ſo ſtrong, that there was no poſſibility of keeping it within bounds. They therefore ſeized upon the military cheſt, dividing the money among themſelves in part of their arrears, put the perſon of Giſco under an arreſt, and treated him as well as his attendants with the utmoſt indignity. Mathos and Spendius, to deſtroy the remoteſt hopes of an accommodation with Carthage, applauded the courage and reſolution of their men, loaded the unhappy Giſco and his followers with irons, and formally declared war againſt the Carthaginians. All the cities of Africa, to whom they had ſent deputies to exhort them to recover their liberty, ſoon came over to them, except Utica and Hippo Diarrhytus. By this means their army being greatly increaſed, they divided it into two parts, with one of which they moved towards Utica, whilſt the other marched to Hippo, in order to beſiege both places. The Carthaginians, in the mean time, found themſelves ready to ſink under the preſſure of their misfortunes. After they had been haraſſed 24 years by a moſt cruel and deſtructive foreign war, they entertained ſome hopes of enjoying repoſe. The citizens of Carthage drew their particular ſubſiſtence from the rents or revenues of their lands, and the public expences from the tribute paid from Africa; all which they were not only deprived of at once, but, what was worſe, had it directly turned againſt them. They were deſtitute of arms and forces either by ſea or land; had made no preparations for the ſuſtaining of a ſiege, or the equipping of a fleet. They ſuffered all the calamities incident to the moſt ruinous civil war; and, to complete their miſery, had not the leaſt proſpect of receiving aſſiſtance from any foreign friend or ally. Notwithſtanding their deplorable ſituation, however, they did not deſpond, but purſued all the meaſures neceſſary to put themſelves into a poſture of defence. Hanno was appointed commander in chief of all their forces; and the moſt ſtrenuous efforts were made, not only to repel all the attempts of the mutineers, but even to reduce them by force of arms.

90
The mercenaries declare war.

In the mean time Mathos and Spendius laid ſiege to Utica and Hippacra at once; but as they were carried on by detachments drawn from the army for that purpoſe, they remained with the main body of their forces at Tunis, and thereby cut off all communication betwixt Carthage and the continent of Africa. By this means the capital was kept in a kind of blockade. The Africans likewiſe haraſſed them by perpetual alarms, advancing to the very walls of Carthage by day as well as by night, and treating with the utmoſt cruelty every Carthaginian that fell into their hands.

91
They are defeated by Hanno.

Hanno was deſpatched to the relief of Utica with a good body of forces, 100 elephants, and a large train of battering engines. Having taken a view of the enemy, he immediately attacked their intrenchments, and after an obſtinate diſpute forced them. The mercenaries loſt a vaſt number of men; and conſequently the advantages gained by Hanno were ſo great, that they might have proved deciſive, had he made a proper uſe of them: But becoming ſecure after his victory, and his troops being everywhere off their duty, the mercenaries, having rallied their forces, fell upon him, cut off many of his men, forced the reſt to fly into the town, retook and plundered the camp, and ſeized all the proviſions, military ſtores, &c. brought to the relief of the beſieged. Nor was this the only inſtance of Hanno's military incapacity. Notwithſtanding he lay encamped in the moſt advantageous manner near a town called *Gorza*, at which place he twice overthrew the enemy, and had it in his power to have totally ruined them, he yet neglected to improve thoſe advantages, and even ſuffered the mercenaries to poſſeſs themſelves of the iſthmus which joined the peninſula on which Carthage ſtood, to the continent of Africa.

92
He is in his turn defeated.

93
Hamilcar Barcas appointed to command againſt them.

Theſe repeated miſtakes induced the Carthaginians once more to place Hamilcar Barcas at the head of their forces. He marched againſt the enemy with 10,000 men, horſe, and foot, being all the troops the

Carthaginians could then aſſemble for their defence; a full proof of the low ſtate to which they were at that time reduced. As Mathos, after he had poſſeſſed himſelf of the iſthmus, had poſted proper detachments in two paſſes on two hills facing the continent, and guarded the bridge over the Bagrada, which through Hanno's neglect he had taken, Hamilcar ſaw little probability of engaging him upon equal terms, or indeed of coming at him. Obſerving, however, that on the blowing of certain winds, the mouth of the river was choaked up with ſand, ſo as to become paſſable, though with no ſmall difficulty, as long as theſe winds continued; he halted for ſome time at the river's mouth, without communicating his deſign to any perſon. As ſoon as the wind favoured his intended project, he paſſed the river privately by night, and immediately after his paſſage, he drew up the troops in order of battle; and advancing into the plain where his elephants were capable of acting, moved towards Mathos who was poſted at the village near the bridge. This daring action greatly ſurpriſed and intimidated the Africans. However, Spendius receiving intelligence of the enemy's motions, drew a body of 10,000 men out of Mathos's camp, with which he attended Hamilcar on one ſide, and ordered 15,000 from Utica to obſerve him on the other, thinking by this means to ſurround the Carthaginians, and cut them all off at one ſtroke.

94
He defeats them.

By feigning a retreat, Hamilcar found means to engage them at a diſadvantage, and gave them a total overthrow, with the loſs of 6000 killed and 2000 taken priſoners. The reſt fled, ſome to the town at the bridge, and others to the camp at Utica. He did not give them time to recover from their defeat, but purſued them to the town near the bridge before mentioned; which he entered without oppoſition, the mercenaries flying in great confuſion to Tunis; and upon this many towns ſubmitted of their own accord to the Carthaginians, whilſt others were reduced by force.

Notwithſtanding theſe diſaſters, Mathos puſhed on the ſiege of Hippo with great vigour, and appointed Spendius and Autaritus, commanders of the Gauls, with a ſtrong body to obſerve the motions of Hamilcar. Theſe two commanders, therefore, at the head of a choice detachment of 6000 men drawn out of the camp at Tunis, and 2000 Gallic horſe, attended the Carthaginian general, approaching him as near as they could with ſafety, and keeping cloſe to the ſkirts of the mountains. At laſt Spendius, having received a ſtrong reinforcement of Africans and Numidians, and poſſeſſing himſelf of all the heights ſurrounding the plain in which Hamilcar lay encamped, reſolved not to let ſlip ſo favourable an opportunity of attacking him. Had a battle now enſued, Hamilcar and his army muſt in all probability have been cut off; but, by the deſertion of one Naravaſus a young Numidian nobleman, with 2000 men, he found himſelf enabled to offer his enemies battle.

95
Mercenaries again defeated.

The fight was obſtinate and bloody; but at laſt the mercenaries were entirely overthrown, with the loſs of 10,000 men killed and 4000 taken priſoners. All the priſoners that were willing to enliſt in the Carthaginian ſervice Hamilcar received among his troops, ſupplying them with the arms of the ſoldiers who had fallen in the engagement. To the reſt he gave full liberty to go where they pleaſed, upon condition that they ſhould never for the future bear arms againſt the Carthaginians; informing them, at the ſame time, however, that as many violators of this agreement as fell into his hands muſt expect to find no mercy.

96
They put to death all the Carthaginian priſoners.

Mathos and his aſſociates, fearing that this affected lenity of Hamilcar might occaſion a defection among the troops, thought that the beſt expedient would be to put them upon ſome action, ſo execrable in its nature that no hopes of reconciliation might remain. By their advice, therefore, Giſco, and all the Carthaginian priſoners were put to death; and when Hamilcar ſent to demand the remains of his countrymen, he received for anſwer, that whoever preſumed hereafter to come upon that errand, ſhould meet with Giſco's fate: after which they came to a reſolution to treat with the ſame barbarity all ſuch Carthaginians as ſhould fall into their hands. In return for this enormity, Hamilcar threw all the priſoners that fell into his hands to be devoured by wild beaſts; being convinced that compaſſion ſerved only to make his enemies more fierce and untractable.

The war was now carried on generally to the advantage of the Carthaginians; nevertheleſs, the malecontents ſtill found themſelves in a capacity to take the field with an army of 50,000 men. They watched Hamilcar's motions, but kept on the hills, carefully avoiding to come down into the plains, on account of the Numidian horſe and Carthaginian elephants. Hamilcar, being much ſuperior in ſkill to any of their generals, at laſt ſhut them up in a poſt, ſo ſituated, that it was impoſſible to get out of it. Here he kept them ſtrictly beſieged: and the mercenaries, not daring to venture a battle, began to fortify their camp, and ſurround it with ditches and intrenchments.

97
They are beſieged by Hamilcar.

They were ſoon preſſed by famine ſo ſorely, that they were obliged to eat one another: but they were driven deſperate by the conſciouſneſs of their guilt, and therefore did not deſire any terms of accommodation. At laſt being reduced to the utmoſt extremity of miſery, they inſiſted that Spendius, Autaritus, and Zarxas, their leaders, ſhould in perſon have a conference with Hamilcar, and make propoſals to him. Peace was accordingly concluded upon the following terms, viz. That ten of the ringleaders of the malecontents ſhould be left entirely to the mercy of the Carthaginians, and that the troops ſhould all be diſarmed, every man retiring only in a ſingle coat. The treaty was no ſooner concluded, than Hamilcar, by virtue of the firſt article, ſeized upon the negociators themſelves; and the army being informed that their chiefs were under arreſt, had immediately recourſe to arms, as ſuſpecting they were betrayed; but Hamilcar, drawing out his army in order of battle, ſurrounded them, and either cut them to pieces, or trod them to death with his elephants.

98
40,000 of them deſtroyed.

The number of wretches who periſhed on this occaſion amounted to above 40,000.

After the deſtruction of the army, Hamilcar inveſted Tunis, whither Mathos had retired with all his remaining forces. Hamilcar had another general, named *Hannibal*, joined in the command with him. Hannibal's quarters was on the road leading to Carthage, and Hamilcar's on the oppoſite ſide. The army was no ſooner encamped, than Hamilcar cauſed Spendius, and the reſt of the priſoners, to be led out in the view of the beſieged, and crucified near the walls. Mathos, however, obſerving that Hannibal did not keep ſo good a guard as he ought to have done, made a ſally, attacked his quarters, killed many of his men, took ſeveral priſoners, among whom was Hannibal himſelf, and plundered his camp. Taking the body of Spendius from the croſs, Mathos immediately ſubſtituted Hannibal in its room; and 30 Carthaginian priſoners of diſtinction were crucified around him. Upon this diſaſter, Hamilcar immediately decamped, and poſted himſelf along the ſea coaſt, near the mouth of the river Bagrada.

99
Hannibal taken and crucified by Mathos.

The ſenate, though greatly terrified by this unexpected blow, omitted no means neceſſary for their preſervation. They ſent 30 ſenators, with Hanno at their head, to conſult with Hamilcar about the proper meaſures for putting at end to this unnatural war, conjuring, in the moſt preſſing manner, Hanno to be reconciled to Hamilcar, and to ſacrifice his private reſentment to the public benefit. This, with ſome difficulty, was effected; and the two generals came to a full reſolution to act in concert for the good of the public. The ſenate at the ſame time, ordered all the youth capable of bearing arms to be preſſed into the ſervice: by which means a ſtrong reinforcement being ſent to Hamilcar, he ſoon found himſelf in a condition to act offenſively. He now defeated the enemy in all rencounters, drew Mathos into frequent ambuſcades, and gave him one notable overthrow near Leptis. This reduced the rebels to the neceſſity of hazarding a deciſive battle, which proved fatal to them. The mercenaries fled almoſt at the firſt onſet; moſt of their army fell in the field of battle, and in the purſuit. Mathos, with a few, eſcaped to a neighbouring town, where he was taken alive, carried to Carthage, and executed; and then by the reduction of the revolted cities an end was put to this war, which, from the exceſſes of cruelty committed in it, according to Polybius, went among the Greeks by the name of the *inexpiable war*.

100
Mathos entirely defeated and taken priſoner.

During the Libyan war, the Romans, upon ſome abſurd pretences, wreſted the iſland of Sardinia from the Carthaginians; which the latter, not being able to reſiſt, were obliged to ſubmit to. Hamilcar, finding his country not in a condition to enter into an immediate war with Rome, formed a ſcheme to put it on a level with that haughty republic. This was by making an entire conqueſt of Spain, by which means the Carthaginians might have troops capable of coping with the Romans. In order to facilitate the execution of this ſcheme, he inſpired both his ſon-in-law Aſdrubal, and his ſon Hannibal, with an implacable averſion to the Romans, as the great oppoſers of his country's grandeur. Having completed all the neceſſary preparations, Hamilcar, after having greatly enlarged the Carthaginian dominions in Africa, entered Spain, where he commanded nine years, during which time he ſubdued many warlike nations, and amaſſed an immenſe quantity of treaſure, which he diſtributed partly amongſt his troops, and partly amongſt the great men at Carthage; by which means he ſupported his intereſts with theſe two powerful bodies. As laſt, he was killed in a battle, and was ſucceeded by his ſon-in-law Aſdrubal. This general fully anſwered the expectations of his countrymen; greatly enlarged their dominions in Spain; and built the city of New Carthage, now Carthagena. He made ſuch progreſs in his conqueſts, that the Romans began to grow jealous. They did not, however, chooſe at preſent to come to an open rupture, on account of the apprehenſions they were under of an invaſion from the Gauls. They judged it moſt proper, therefore, to have recourſe to milder methods; and prevailed upon Aſdrubal to conclude a new treaty with them. The articles of it were, 1. That the Carthaginians ſhould not paſs the Iberus. 2. That the Saguntines, a colony of Zacynthians, and a city ſituated between the Iberus and that part of Spain ſubject to the Carthaginians, as well as the other Greek colonies there, ſhould enjoy their ancient rights and privileges.

101
Hamilcar's ſcheme to equal Carthage with Rome.

102
His death.

103
Aſdrubal's treaty with the Romans.

Aſdrubal, after having governed the Carthaginian dominions in Spain for eight years, was treacherouſly murdered by a Gaul, whoſe maſter he had put to death. Three years before this happened, he had written to Carthage, to deſire that young Hannibal, then twenty-two years of age, might be ſent to him. This requeſt was complied with, notwithſtanding the oppoſition of Hanno: and, from the firſt arrival of the young man in the camp, he became the darling of the whole army. The great reſemblance he bore to Hamilcar rendered him extremely agreeable to the troops. Every talent and qualification he ſeemed to poſſeſs, that contribute towards forming a great man. After the death of Aſdrubal, he was ſaluted general by the army with the higheſt demonſtration of joy. He immediately put himſelf in motion: and in the firſt campaign conquered the Olcades, a nation ſeated near the Iberus. The next year he ſubdued the Vaccæi, another nation in that neighbourhood. Soon after, the Carpætani, one of the moſt powerful nations in Spain, declared againſt the Carthaginians. Their army conſiſted of 100,000 men, with which they propoſed to attack Hannibal on his return from the Vaccæi; but by a ſtratagem they were utterly defeated, and the whole nation obliged to ſubmit.

104
He is murdered.

105
Succeeded by Hannibal, who makes vaſt conqueſts in Spain.

Nothing now remained to oppoſe the progreſs of the Carthaginian arms but the city of Saguntum. Hannibal, however, for ſome time, did not think proper to come to a rupture with the Romans by attacking that place. At laſt he found means to embroil ſome of the neighbouring cantons, eſpecially the Turdetani, or, as Appian calls them, the *Turboletæ*, with the Saguntines, and thus furniſhed himſelf with a pretence to attack their city. Upon the commencement of the ſiege, the Roman ſenate deſpatched two ambaſſadors to Hannibal, with orders to proceed to Carthage, in caſe the general refuſed to give them ſatisfaction. They were ſcarce landed, when Hannibal, who was carrying on the ſiege of Saguntum with great vigour, ſent them word that he had ſomething elſe to do than to give audience to ambaſſadors. At laſt, however, he admitted them; and, in anſwer to their remonſtrances, told them, that the Saguntines had drawn their misfortunes upon themſelves, by committing hoſtilities againſt the allies of Carthage; and at the ſame time deſired the deputies, if they had any complaints to make of them, to carry them to the ſenate of Carthage. On their arrival in that capital, they demanded that Hannibal might be delivered up to the Romans to be puniſhed according to his deſerts; and

106
He attacks Saguntum.

and this not being complied with, war was immediately declared between the two nations.

107 and takes it.

The Saguntines are ſaid to have defended themſelves for eight months with incredible bravery. At laſt, however, the city was taken, and the inhabitants were treated with the utmoſt cruelty. After this conqueſt, Hannibal put his African troops into winter quarters at New Carthage; but in order to gain their affection, he permitted the Spaniards to retire to their reſpective homes.

108 He ſets out for Italy.

The next campaign, having taken the neceſſary meaſures for ſecuring Africa and Spain, he paſſed the Iberus, ſubdued all the nations betwixt that river and the Pyrenees, appointed Hanno commander of all the new conquered diſtrict, and immediately began his march for Italy. Upon muſtering his forces, after they had been weakened by ſieges, deſertion, mortality, and a detachment of 10,000 foot and 1000 horſe, left with Hanno to ſupport him in his new poſt, he found them to amount to 50,000 foot and 9000 horſe all veteran troops, and the beſt in the world. As they had left their heavy baggage with Hanno, and were all light-armed, Hannibal eaſily croſſed the Pyrenees; paſſed by Ruſcino, a frontier town of the Gauls, and arrived on the banks of the Rhone without oppoſition. This river he paſſed, notwithſtanding of ſome oppoſition from the Gauls; and was for ſome time in doubt whether he ſhould advance to engage the Romans, who, under Scipio, were bending their march that way, or continue his march for Italy. But to the latter he was ſoon determined by the arrival of Magilus, prince of the Boii, who brought rich preſents with him, and offered to conduct the Carthaginian army over the Alps. Nothing could have happeded more favourable to Hannibal's affairs than the arrival of this prince, ſince there was no room to doubt the ſincerity of his intentions. For the Boii bore an implacable enmity to the Romans, and had even come to an open rupture with them, upon the firſt news that Italy was threatened with an invaſion from the Carthaginians.

109 He croſſes the Alps.

It is not known with certainty where Hannibal began to aſcend the Alps. As ſoon as he began his march, the petty kings of the country aſſembled their forces in great numbers; and, taking poſſeſſion of the eminences over which the Carthaginians muſt neceſſarily paſs, they continued haraſſing them, and were no ſooner driven from one eminence than they ſeized on another, diſputing every foot of land with the enemy, and deſtroyed great numbers of them by the advantage they had of the ground. Hannibal, however, having found means to poſſeſs himſelf of an advantageous poſt, defeated and diſperſed the enemy; and ſoon after took their capital city, where he found the priſoners, horſes, &c. that had before fallen into the hands of the enemy, and likewiſe corn ſufficient to ſerve the army for three days. At laſt, after a moſt fatiguing march of nine days, he arrived at the top of the mountains. Here he encamped, and halted two days, to give his wearied troops ſome repoſe, and to wait for the ſtragglers. As the ſnow had lately fallen in great plenty, and covered the ground, this ſight terrified the Africans and Spaniards, who were much affected with the cold. In order, therefore, to encourage them, the Carthaginian general led them to the top of the higheſt rock on the ſide of Italy, and thence gave them a view of the large and fruitful plains of Inſubria, acquainting them that the Gauls, whoſe country they ſaw, were ready to join them. He alſo pointed out to them the place whereabout Rome ſtood, telling them, that by climbing the Alps they had ſcaled the walls of that rich metropolis; and, having thus animated his troops, he decamped, and began to deſcend the mountains. The difficulties they met with in their deſcent were much greater than thoſe that had occurred while they aſcended. They had indeed no enemy to contend with, except ſome ſcattered parties that came to ſteal rather than to fight; but the deep ſnows, the mountains of ice, craggy rocks, and frightful precipices, proved more terrible than any enemy. After they had for ſome days marched through narrow, ſteep, and ſlippery ways, they came at laſt to a place which neither elephants, horſes, nor men, could paſs. The way, which lay between two precipices, was exceeding narrow; and the declivity, which was very ſteep, had become more dangerous by the falling away of the earth. Here the guides ſtopped; and the whole army being terrified, Hannibal propoſed at firſt to march round about, and attempt ſome other way: but all places round him being covered with ſnow, he found himſelf reduced to the neceſſity of cutting a way into the rock itſelf, through which his men, horſes, and elephants, might deſcend. This work was accompliſhed with incredible labour; and then Hannibal, having ſpent nine days in aſcending, and ſix in deſcending, the Alps, gained at length Inſubria; and, notwithſtanding all the diſaſters he had met with by the way, entered the country with all the boldneſs of a conqueror.

110 Taurinum taken.

Hannibal, on his entry into Inſubria, reviewed his army; when he found that of the 50,000 foot, with whom he ſet out from New Carthage five months and 15 days before, he had now but 20,000, and that his 9000 horſe were reduced to 6000. His firſt care, after he entered Italy, was to refreſh his troops; who, after ſo long a march, and ſuch inexpreſſible hardſhips, looked like as many ſkeletons raiſed from the dead, or ſavages born in a deſert. He did not, however ſuffer them to languiſh long in idleneſs; but, joining the Inſubrians, who were at war with the Taurinians, laid ſiege to Taurinum, the only city in the country, and in three days time became maſter of it, putting all who reſiſted to the ſword. This ſtruck the neighbouring barbarians with ſuch terror, that of their own accord they ſubmitted to the conqueror, and ſupplied his army with all ſorts of proviſions.

111 The Romans defeated near the Ticinus.

Scipio, the Roman general, in the mean time, who had gone in queſt of Hannibal on the banks of the Rhone, was ſurpriſed to find his antagoniſt had croſſed the Alps and entered Italy. He therefore returned with the utmoſt expedition. An engagement enſued near the river Ticinus, in which the Romans were defeated. The immediate conſequence was, that Scipio repaſſed that river, and Hannibal continued his march to the banks of the Po. Here he ſtaid two days, before he could croſs that river over a bridge of boats. He then ſent Mago in purſuit of the enemy, who, having rallied their ſcattered forces, and repaſſed the Po, were encamped at Placentia. Afterwards having concluded a treaty with ſeveral of the Gallic cantons, he joined his brother with the reſt of the army, and again offered battle to the Romans: but this they thought proper to decline; and at laſt the conſul being intimidated by the deſertion of a body of Gauls, abandoned his camp, paſſed the Trebia, and poſted himſelf on an eminence near that river. Here he drew lines round his camp, and waited the arrival of his colleague with the forces from Sicily.

111
They are again defeated.

Hannibal being appriſed of the conſul's departure, ſent out the Numidian horſe to haraſs him on his march; himſelf moving with the main body to ſupport them in caſe of need. The Numidians arriving before the rear of the Roman army had quite paſſed the Trebia, put to the ſword or made priſoners all the ſtragglers they found there. Soon after, Hannibal coming up, encamped in ſight of the Roman army on the oppoſite bank. Here having learned the character of the conſul Sempronius lately arrived, he ſoon brought him to an engagement, and entirely defeated him. Ten thouſand of the enemy retired to Placentia; but the reſt were either killed or taken priſoners. The Carthaginians purſued the flying Romans as far as the Trebia, but did not think proper to repaſs that river on account of the exceſſive cold.

Hannibal, after this action upon the Trebia, ordered the Numidians, Celtiberians, and Luſitanians, to make incurſions into the Roman territories, where they committed great devaſtations. During his ſtate of inaction, he endeavoured to win the affections of the Gauls, and likewiſe of the allies of the Romans; declaring to the Gallic and Italian priſoners, that he had no intention of making war upon them, being determined to reſtore them to their liberty, and protect them againſt the Romans: and to confirm them in their good opinion of him, he diſmiſſed them all without ranſom.

113
They are utterly defeated near the lake Thraſymenus.

Next year having croſſed the Appenines, and penetrated into Etruria, Hannibal received intelligence that the new conſul Flaminius lay encamped with the Roman army under the walls of Aretium. Having learned the true character of this general, that he was of a haughty, fierce, and raſh diſpoſition, he doubted not of being ſoon able to bring him to a battle. To inflame the impetuous ſpirit of Flaminius, the Carthaginian general took the road to Rome, and, leaving the Roman army behind him, deſtroyed all the country through which he paſſed with fire and ſword; and as that part of Italy abounded with all the elegancies as well as neceſſaries of life, the Romans and their allies ſuffered an incredible loſs on this occaſion. The raſh conſul was inflamed with the utmoſt rage, on ſeeing the ravages committed by the Carthaginians; and therefore immediately approached them with great temerity, as if certain of victory. Hannibal in the mean time kept on, ſtill advancing towards Rome, having Crotona on the left hand, and the lake Thraſymenus on the right; and at laſt, having drawn Flaminius into an ambuſcade, entirely defeated him. The general himſelf, with 15,000 of his men, fell on the field of battle. A great number were likewiſe taken priſoners; and a body of 6000 men, who had fled to a town in Etruria, ſurrendered to Maherbal the next day. Hannibal loſt only 1500 men on this occaſion, moſt of whom were Gauls; though great numbers, both of his ſoldiers and of the Romans, died of their wounds. Being ſoon after informed that the conſul Servilius had detached a body of 4000, or, according to Apian, 8000 horſe from Ariminum, to reinforce his colleague in Etruria, Hannibal ſent out Maherbal, with all the cavalry, and ſome of the infantry, to attack him.—The Roman detachment conſiſted of choſen men, and was commanded by Centenius a patrician. Maherbal had the good fortune to meet with him, and after a ſhort diſpute entirely defeated him. Two thouſand of the Romans were laid dead on the ſpot; the reſt, retiring to a neighbouring eminence, were ſurrounded by Maherbal's forces, and obliged next day to ſurrender at diſcretion; and this diſaſter, happening within a few days after the defeat at the lake Thraſymenus, almoſt gave the finiſhing ſtroke to the Roman affairs.

114
A Roman detachment cut to pieces or taken.

The Carthaginian army was now ſo much troubled with a ſcorbutic diſorder, owing to the unwholeſome encampments they had been obliged to make, and the moraſſes they had paſſed through, that Hannibal found it abſolutely neceſſary to repoſe them for ſome time in the territory of Adria, a moſt pleaſant and fertile country. In his various engagements with the Romans, he had taken a great number of their arms, with which he now armed his men after the Roman manner. Being now likewiſe maſter of that part of the country bordering on the ſea, he found means to ſend an expreſs to Carthage with the news of the glorious progreſs of his arms. The citizens received this news with the moſt joyful acclamations, at the ſame time coming to a reſolution to reinforce their armies both in Italy and Spain, with a proper number of troops.

115
Fabius Maximus named dictator.

The Romans being now in the utmoſt conſternation, named a dictator, as was their cuſtom in times of great danger. The perſon they choſe to this office was Fabius Maximus, ſurnamed *Verruscoſus*; a man as cool and cautious as Sempronius and Flaminius were warm and impetuous. He ſet out with a deſign not to engage Hannibal, but only to watch his motions and cut off his proviſions, which he knew was the moſt proper way to deſtroy him in a country ſo far from his own. Accordingly he followed him through Umbria and Picenum, into the territory of Adria, and then through the territories of the Marrucini, and Frentani into Apulia. When the enemy marched he followed them: when they encamped, he did the ſame: but for the moſt part on eminences, and at ſome diſtance from their camp, watching all their motions, cutting off their ſtragglers, and keeping them in a continual alarm. This cautious method of proceeding greatly diſtreſſed the Carthaginians, but at the ſame time raiſed diſcontents in his own army. But neither theſe diſcontents, nor the ravages committed by Hannibal, could prevail upon Fabius to alter his meaſures. The former, therefore, entered Campania, one of the fineſt countries of Italy. The ravages he committed there raiſed ſuch complaints in the Roman army, that the dictator, for fear of irritating his ſoldiers, was obliged to pretend a deſire of coming to an engagement. Accordingly he followed Hannibal with more expedition than uſual; but at the ſame time avoided, under various pretences, an engagement with more care than the enemy ſought it. Hannibal, finding he could not by any means bring the dictator to a battle, reſolved to quit Campania, which he found abounding more with fruit and wine than corn, and to return to Samnium through the paſs called Eribanus. Fabius concluding from his march that this was his deſign, got there before him, and encamped on Mount Callicula, which commanded the paſs, after having placed ſeveral bodies in all the avenues leading to it.

116
He is outwitted by Hannibal.

Hannibal was for ſome time at a loſs what to do; but at laſt contrived the following ſtratagem, which Fabius could not foreſee nor guard againſt. Being encamped at the foot of Mount Callicula, he ordered Aſdrubal to pick out of the cattle taken in the country 2000 of the ſtrongeſt and nimbleſt oxen, to tie faggots to their horns, and to have them and the herdſmen ready without the camp. After ſupper, when all was quiet, the cattle were brought in good order to the hill, where Fabius had placed ſome Roman parties in ambuſh to ſtop up the paſs. Upon a ſignal given, the faggots on the horns of the oxen were ſet on fire; and the herdſmen, ſupported by ſome battalions armed with ſmall javelins, drove them on quietly. The Romans, ſeeing the light of the fires, imagined that the Carthaginians were marching by torch light. However, Fabius kept cloſe in his camp, depending on the troops he had placed in ambuſcade; but when the oxen, feeling the fire on their heads, began to run up and down the hills, the Romans in ambuſh thinking themſelves ſurrounded on all ſides, and climbing the ways where they ſaw leaſt light, returned to their camp, leaving the paſs open to Hannibal. Fabius, though rallied by his ſoldiers for being thus overreached by the Carthaginian, ſtill continued to purſue the ſame plan, marched directly after Hannibal, and encamped on ſome eminences near him.

Soon after this, the dictator was recalled to Rome; and as Hannibal, notwithſtanding the terrible ravages he had committed, had all along ſpared the lands of Fabius, the latter was ſuſpected of holding a ſecret correſpondence with the enemy. In his abſence, Minucius, the general of the horſe, gained ſome advantages, which greatly tended to increaſe the diſcontent with the dictator, inſomuch that before his return Minucius was put upon an equal footing with himſelf. The general of the horſe propoſed that each ſhould command his day; but the dictator choſe rather to divide the army, hoping by that means to ſave at leaſt a part of it.

117
Minucius in great danger is relieved by Fabius.

Hannibal ſoon found means to draw Minucius to an engagement, and by his maſterly ſkill in laying ambuſhes, the Roman general was ſurrounded on every ſide, and would have been cut off with all his troops, had not Fabius haſtened to his aſſiſtance, and relieved him. Then the two armies uniting, advanced in good order to renew the fight; but Hannibal, not caring to venture a ſecond action, ſounded a retreat, and retired to his camp; and Minucius, being aſhamed of his raſhneſs, reſigned the command of the army to Fabius.

118
The Romans utterly defeated at Cannæ.

The year following, the Romans augmented their army to 87,000 men, horſe and foot, under the command of Æmilius Paulus and Terentius Varro, the conſuls for the year; and Hannibal being reduced to the greateſt ſtraits for want of proviſions, reſolved to leave Samnium, and penetrate into the heart of Apulia. Accordingly he decamped in the night; and by leaving fires burning, and tents ſtanding in his camp, made the Romans believe for ſome time that his retreat was only feigned. When the truth was diſcovered, Æmilius was againſt purſuing him; but in this he was ſeconded by few beſides Servilius, one of the conſuls of the preceding year; Terentius and all the other officers being obſtinately bent on purſuing the enemy. They accordingly overtook them at Cannæ, till this time an obſcure village in Apulia *. A battle enſued at this place, as memorable as any mentioned in hiſtory; in which the Romans, though almoſt double in number to the Carthaginians, were put to flight with moſt terrible ſlaughter; at leaſt 45,000 of them being left dead on the field of battle, and 10,000 taken priſoners in the action or purſuit. The night was ſpent in Hannibal's camp in feaſting and rejoicings, and next day in ſtripping the dead bodies of the unhappy Romans; after which the victorious general inveſted their two camps, where he found 4000 men.

199
Conſequences of this victory.

The immediate conſequence of this victory, as Hannibal had foreſeen, was a diſpoſition of that part of Italy called the Old Province, Magna Grecia, Tarentum, and part of the territory of Capua, to ſubmit to him. The neighbouring provinces likewiſe diſcovered an inclination to ſhake off the Roman yoke, but wanted firſt to ſee whether Hannibal was able to protect them. His firſt march was into Samnium, being informed that the Hirpini and other neighbouring nations were diſpoſed to enter into an alliance with the Carthaginians. He advanced to Compſa, which opened its gates to him. In this place he left his heavy baggage, as well as the immenſe plunder he had acquired. After which he ordered his brother Mago, with a body of troops deſtined for that purpoſe, to poſſeſs himſelf of all the fortreſſes in Campania, the moſt delicious province of Italy. The humanity Hannibal had all along ſhown the Italian priſoners, as well as the fame of the complete victory he had lately obtained, wrought ſo powerfully upon the Lucani, Bruttii, and Apulians, that they expreſſed an eager deſire of being taken under his protection. Nay, even the Campanians themſelves, a nation more obliged to the Romans than any in Italy, except the Latins, diſcovered an inclination to abandon their natural friends.

120
Capua ſubmits to Hannibal.

Of this the Carthaginian general receiving intelligence, he bent his march towards Capua, not doubting but that, by means of the popular faction there, he ſhould eaſily make himſelf maſter of it; which accordingly happened. Soon after this place had made its ſubmiſſion, many cities of the Bruttii opened their gates to Hannibal, who ordered his brother Mago to take poſſeſſion of them. Mago was then diſpatched to Carthage, with the important news of the victory at Cannæ, and the conſequences attending it.

121
Mago's account of Hannibal's ſucceſs.

Upon his arrival there, he acquainted the ſenate, that Hannibal had defeated ſix Roman generals, four of whom were conſuls, one dictator, and the other general of horſe to the dictator: that he had engaged ſix conſular armies, killed two conſuls, wounded one, and driven another out of the field, with ſcarce 50 men to attend him: that he had routed the general of the horſe, who was of equal power with the conſuls; and that the dictator was eſteemed the only general fit to command an army, merely becauſe he had not the courage to engage him; and as a demonſtrative proof of what he advanced, he produced, according to ſome authors,

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* See *Cannæ*.

authors, three buſhels and a half of gold rings, taken from knights and ſenators who had been killed in the various engagements.

122 Hannibal ſuperior to every other general mentioned in hiſtory.

Hitherto we have ſeen Hannibal ſurpriſingly victorious; and, indeed, if we conſider what he had already done, we ſhall find his exploits ſuperior to thoſe of any other general, either ancient or modern. Other commanders have been celebrated for victories gained over barbarous and uncivilized nations. Alexander the Great invaded and overran the empire of Perſia; but that kingdom was then ſunk in ſloth and effeminacy, ſo as to be an eaſy conqueſt: but had that great commander turned his arms againſt the weſtern nations, who were of a more martial diſpoſition, it is more than probable he had not conquered ſo eaſily. Hannibal, on the other hand, lived at a time when the Romans were not only the moſt powerful, but the moſt warlike nation in the whole world. That nation he attacked with an army of only 26,000 men, without reſources either for recruits, money, or proviſions, except what he could procure in the enemy's country. With theſe he had for three years reſiſted the Roman armies; which had been hitherto invincible by all other nations. Their armies had been commanded by generals of different tempers, diſpoſitions, and abilities: the loſſes they ſuſtained are by the Roman writers imputed to the faults of the generals themſelves; but experience had abundantly ſhown, that theſe commanders, with all their faults, were able to conquer the moſt warlike nations, when commanded by another than Hannibal. In the battles fought with the Romans he had deſtroyed 200,000 of their men, and taken 50,000 priſoners; yet from the time of the battle of Cannæ, the affairs of this great man totally declined. The reaſon of this is, by the Roman hiſtorians, ſaid to be, that when he put his army into winter quarters in Capua, he ſo enervated himſelf and his army by debaucheries in that place, that he became no longer capable of coping with the Roman forces. But this ſeems by no means to have been the caſe; for the Roman hiſtorians themſelves own, that, after the battle of Cannæ, he gave their armies many and terrible defeats, and took a great number of towns in their ſight.

123 Cauſe of the decline of his affairs.

The true reaſon of that reverſe of fortune which Hannibal now experienced, was his not having ſufficient reſources for recruiting his army. On the firſt news, indeed, of his ſucceſs at Carthage, a body of 4000 Numidian cavalry, 40 elephants, and 1000 talents of ſilver, were granted by the ſenate. A large detachment of Spaniſh forces was alſo appointed to follow them; and that theſe laſt might be ready in due time, Maga ſet out immediately for Spain to raiſe 20,000 foot and 4000 horſe there. Had this ample ſupply been ſent with proper expedition, it is by no means probable that the Romans would have had any occaſion to reflect upon Hannibal's conduct at Capua. That general would undoubtedly have obliged the haughty republic to ſubmit to the ſuperior force of his arms the next campaign. But, notwithſtanding the influence of the Barcinian faction at Carthage, Hanno and his adherents found means not only to retard the march of the ſupplies intended, but even to diminiſh their number. Mago, through the artifices of that infatuated party, could obtain an order for only 12,000 foot and 2500 horſe; and even with this inconſiderable body of troops he was ſent into Spain. Hannibal being thus deſerted by his country, found himſelf obliged to act on the defenſive; his army amounting to no more now than 26,000 foot and 9000 horſe. But though obliged to act in this manner, he was only hindered from conquering; the utmoſt efforts of the whole Roman power not being able to drive this ſmall army out of Italy for more than 14 years.

124 Meaſures taken by the Romans.

The Romans, though greatly reduced, were not yet exhauſted. They were able ſtill to ſend two conſular armies into the field, fully recruited and in good order; and as neither the Gauls nor Italians were natural allies of the Carthaginians, they did not fail to abandon them on the firſt reverſe of fortune. After the Romans had recovered from the conſternation into which they were thrown by the defeat at Cannæ, they choſe a dictator, and recalled Marcellus, the conqueror of Syracuſe, from Sicily. All the young Romans, above 17 years of age, of what rank ſoever, were obliged to inliſt themſelves; as were alſo thoſe who had already ſerved their legal time. By this means four legions and 10,000 horſe were ſoon raiſed in the city. The allies of Rome, the colonies, and the municipia, furniſhed their contingence as uſual. To theſe were added 8000 of the youngeſt and ſtrongeſt ſlaves in the city. The republic purchaſed them of their maſters, but did not oblige them to ſerve without their own conſent, which they gave, by anſwering *Volo* "I am willing;" whence they were called *volones*, to diſtinguiſh them from the other troops. As the Romans, after the loſs of ſo many battles, had no ſwords, darts, or bucklers, left in their magazines, the *volones* were ſupplied with the arms which had been formerly taken from the enemy, and hung up in the pubilc temples and porticoes. The finances of Rome were no leſs exhauſted: but this defect was ſupplied by the liberality of her citizens. The ſenators ſhewing the example, were followed firſt by the knights, and afterwards by all the tribes; who ſtripping themſelves of all the gold they had, brought it to the public treaſury. The ſenators only reſerved their rings, and the *bullæ* about their children's necks. As for the ſilver coin, it was now, for the firſt time, alloyed with copper, and increaſed in its value. Thus the finances were put into a good condition, and a competent army raiſed.

This was plainly the laſt effort the Romans could make; and could Hannibal have procured a ſufficient ſupply of men and money to enable him to cope with this army, and to break it as he had done the others before, there could have been no more reſiſtance made on their part. He began, however, to be in want of money; and to procure it, gave the Roman priſoners leave to redeem themſelves. Theſe unhappy men agreed to ſend ten of their body to Rome to negotiate their redemption; and Hannibal required no other ſecurity for their return but their oath. Carthalo was ſent at the head of them to make propoſals of peace; but upon the firſt news of his arrival, the dictator ſent a lictor to him, commanding him immediately to depart the Roman territory; and it was reſolved not to redeem the captives. Upon this Hannibal ſent the moſt conſiderable of them to Carthage; and of the reſt he made gladiators, obliging them to fight with one another,

125 They refuſe to treat of peace.

another, even relations with relations, for the entertainment of the troops.

126 Aſdrubal defeated by the Romans in Spain.

All this time Cneius and Publius Scipio had carried on the war in Spain with great ſucceſs againſt the Carthaginians. Aſdrubal had been ordered to enter Italy with his army to aſſiſt Hannibal; but being defeated by the Romans, was prevented. The dictator and ſenate of Rome, encouraged by this news, carried on the preparations for the next campaign with the greateſt vigour, whilſt Hannibal remained inactive at Capua. This inaction, however, ſeems to have proceeded from his expectation of ſuccours from Africa, which never came, and which delay occaſioned his ruin. The Roman dictator now releaſed from priſon all criminals, and perſons confined for debt, who were willing to inliſt themſelves. Of theſe he formed a body of 6000 foot, armed with the broad ſwords and bucklers formerly taken from the Gauls. Then the Roman army, to the number of about 25,000 men, marched out of the city under the command of the dictator; while Marcellus kept the remains of Varro's army, amounting to about 15,000 men, at Caſilinum, in readineſs to march whenever there ſhould be occaſion.

Thus the Roman forces were ſtill ſuperior to thoſe of Hannibal; and as they now ſaw the neceſſity of following the example of Fabius Maximus, no engagement of any conſequence happened the firſt year after the battle of Cannæ.

127 Marcellus gains an advantage over Hannibal.

Hannibal made a fruitleſs attempt upon Nola, expecting it would be delivered up to him; but this was prevented by Marcellus, who had entered that city, and ſallying unexpectedly from three gates upon the Carthaginians, obliged them to retire in great confuſion, with the loſs of 5000 men. This was the firſt advantage that had been gained by the Romans where Hannibal had commanded in perſon, and raiſed the ſpirits of the former not a little. They were, however, greatly dejected, on hearing that the conſul Poſthumius Albinus, with his whole army, had been cut off by the Boii, as he was croſſing a foreſt. Upon this it was reſolved to draw all the Roman forces out of Gaul and other countries, and turn them againſt Hannibal; ſo that the Carthaginian ſtood daily more and more in need of thoſe ſupplies, which yet never arrived from Carthage.

128 Hannibal takes ſeveral cities.

He reduced, however, the cities of Nuceria, Caſilinum, Petelia, Conſentia, Crotona, Locri, and ſeveral others in Great Greece, before the Romans gained any advantage over him, except that before Nola, already mentioned. The Campanians, who had eſpouſed the Carthaginian intereſt, raiſed an army of 14,000 of their own nation in favour of Hannibal, and put one Marius Alfius at the head of it; but he was ſurpriſed by the conſul Sempronius, who defeated and killed him, with 2000 of his men. It was now found that Hannibal had concluded a treaty of alliance, offenſive and defenſive, with Philip king of Macedon: but, to prevent any diſturbance from that quarter, a Roman army was ſent to Macedon.

129 He is defeated by Marcellus.

Soon after this Marcellus defeated Hannibal in a pitched battle, having armed his men with long pikes uſed generally at ſea, and chiefly in boarding of ſhips; by which means the Carthaginians were pierced through, while they were totally unable to hurt their adverſaries with the ſhort javelins they carried. Marcellus purſued them cloſe; and before they got to their camp, killed 5000, and took 600 priſoners; loſing himſelf about 1000 men, who were trod down by the Numidian horſe, commanded by Hannibal in perſon.

130 He is deſerted by a party of horſe.

After this defeat the Carthaginian general found himſelf deſerted by 1200 of his beſt horſe, partly Spaniards, and partly Numidians, who had croſſed the Alps with him. This touched him ſo ſenſibly, that he left Campania, and retired into Apulia.

The Romans ſtill continued to increaſe their forces; and Hannibal, not having the ſame reſources, found it impoſſible to act againſt ſo many armies at once. Fabius Maximus advanced into Campania, whether Hannibal was obliged to return, in order to ſave Capua. He ordered Hanno, however, at the head of 17,000 foot and 1700 horſe, to ſeize Beneventum; but he was utterly defeated, ſcarce 2000 of his men being left alive.

131 He is again defeated, and begins to loſe ground.

Hannibal himſelf, in the mean time, advanced to Nola, where he was again defeated by Marcellus. He now began to loſe ground; the Romans retook Caſilinum, Accua in Apulia, Arpi, and Aternum; but the city of Tarentum was delivered up to him by its inhabitants. The Romans then entered Campania, and ravaged the whole country, threatening Capua with a ſiege. The inhabitants immediately acquainted Hannibal with their danger; but he was ſo intent upon reducing the citadel of Tarentum, that he could not be prevailed upon to come to their aſſiſtance. In the mean time Hanno was again utterly defeated by Fulvius, his camp taken, and he himſelf forced to fly into Bruttium, with a ſmall body of horſe. The conſuls then advanced with a deſign to beſiege Capua in form. But in their way, Sempronius Gracchus, a man of great bravery, and an excellent general, was betrayed by a Lucanian and killed, which proved a very great detriment to the republic.

132 Capua beſieged by the Romans.

Capua, however, was ſoon after inveſted on all ſides; and the beſieged once more ſent to Hannibal, who now came to their aſſiſtance with his horſe, his light-armed infantry, and 33 elephants.

133 Hannibal in vain attempts to relieve it.

He found means to inform the beſieged of the time he deſigned to attack the Romans, ordering them to make a vigorous ſally at the ſame time. The Roman generals, Appius and Fulvius, upon the firſt news of the enemy's approach, divided their troops: Appius taking upon him to make head againſt the garriſon, and Fulvius to defend the intrenchments againſt Hannibal. The former found no difficulty in repulſing the garriſon: and would have entered the city with them, had he not been wounded at the very gate, which prevented him from purſuing his deſign. Fulvius found it more difficult to withſtand Hannibal, whoſe troops behaved themſelves with extraordinary reſolution. A body of Spaniards and Numidians had even the boldneſs to paſs the ditch, and, in ſpite of all oppoſition, climbing the ramparts, penetrated into the Roman camp; but, not being properly ſeconded by the reſt, they were all to a man cut in pieces. The Carthaginian general was ſo diſheartened at this, eſpecially after the garriſon was repulſed, that he ſounded a retreat, which was made in good order.

134 He marches to Rome.

His next attempt for the relief of Capua was to march to Rome, where he hoped his approach would ſtrike ſo much terror, that the armies would be called from before Capua; and that the Capuans might not be diſheartened by his ſudden departure, he found

mean

135
He ſurpriſes and defeats Appius.

136
Capua ſubmits to the Romans.

means to acquaint them with his deſign. The news of his approach cauſed great conſternation in the metropolis. Some of the ſenators were for calling all the armies in Italy into the neighbourhood of Rome, as thinking nothing leſs was able to reſiſt the terrible Carthaginian. But Fabius told them that Hannibal's deſign was not to take Rome, but relieve Capua; upon which Fulvius was recalled to Rome with 15,000 foot and 1000 horſe; and this obliged Hannibal again to retire. He then returned before Capua ſo ſuddenly that he ſurpriſed Appius in his camp, drove him out of it with the loſs of a great number of men, and obliged him to intrench himſelf on ſome eminences, where he expected to be ſoon joined by his colleague Fulvius. As Hannibal, however, now expected to have all the Roman forces upon him, he could do nothing more for the relief of Capua; which was of conſequence obliged to ſubmit to the Romans.

137
Centenius Penula defeated by Hannibal;

138
as alſo the prætor Fulvius.

139
and the proconſul Fulvius Centumalus.

A little before the ſurrender of Capua, Hannibal came up with a Roman army commanded by one M. Centenius Penula, who had ſignalized himſelf on many occaſions as a centurion. This raſh man, being introduced to the ſenate, had the aſſurance to tell them, that if they would truſt him with a body of only 5000 men, he would give a good account of Hannibal. They gave him 8000, and his army was ſoon increaſed to double that number. He engaged the Carthaginians on Hannibal's firſt offering him battle; but, after an engagement of two hours, was defeated, himſelf and all his men being ſlain except about 1000. Soon after, having found means to draw the prætor Cneius Fulvius into an ambuſcade, Hannibal cut in pieces almoſt his whole army, conſiſting of 18,000 men. In the mean time Marcellus was making great progreſs in Samnium. The city of Salapia was betrayed to him; but he took other two by aſſault. In the laſt of theſe he found 3000 Carthaginians, whom he put to the ſword; and carried off 240,000 buſhels of wheat, and 110,000 of barley. This, however, was by no means a compenſation for the defeat which Hannibal ſoon after gave the proconſul Fulvius Centumalus, whom he ſurpriſed and cut off, with 13,000 of his men.

140
Marcellus drawn into an ambuſcade and killed.

After this defeat the great Marcellus advanced with his army to oppoſe Hannibal. Various engagements happened without any thing deciſive. In one of them the Romans are ſaid to have been defeated, and in another Hannibal; but notwithſtanding theſe, it was neither in the power of Marcellus, nor any other Roman general, totally to defeat or diſperſe the army commanded by Hannibal in perſon. Nay, in the eleventh year of the war, Hannibal found means to decoy into an ambuſcade and cut off the great Marcellus himſelf; the conſequence of which was, that the Romans were obliged to raiſe the ſiege of Locri, with the loſs of all their military engines.

141
Carthaginian affairs totally ruined by the defeat of Aſdrubal.

Hitherto the Carthaginians, though no longer the favourites of fortune, had loſt but little ground; but now they met with a blow which totally ruined their affairs. This was the defeat of Aſdrubal, Hannibal's brother, who had left Spain, and was marching to his aſſiſtance. He croſſed the Pyrenees, without any difficulty; and, as the ſilver mines had ſupplied him with a very conſiderable quantity of treaſure, he not only prevailed upon the Gauls to grant him a paſſage through their territories, but likewiſe to furniſh him with a conſiderable number of recruits. Meeting with many favourable circumſtances to expedite his march, he arrived at Placentia ſooner than the Romans or even his brother Hannibal expected. Had he continued to uſe the ſame expedition with which he ſet out, and haſtened to join his brother, it would have been utterly impoſſible to have ſaved Rome; but, ſitting down before Placentia, he gave the Romans an opportunity of aſſembling all their forces to attack him. At laſt he was obliged to raiſe the ſiege, and began his march for Umbria. He ſent a letter to acquaint his brother of his intended motion; but the meſſenger was intercepted: and the two conſuls, joining their armies, with united forces fell upon the Carthaginians. As the letter were inferior both in numbers and reſolution, they were utterly defeated, and Aſdrubal was killed. About the ſame time, Hannibal himſelf is ſaid to have ſuffered ſeveral defeats, and was retired to Canuſium: but, on the fatal news of his brother's defeat and death, he was filled with deſpair, and retired to the extremity of Bruttium: where, aſſembling all his forces, he remained for a conſiderable time in a ſtate of inaction, the Romans not daring to diſturb him; ſo formidable did they eſteem him alone; though every thing about him went to wreck, and the Carthaginian affairs ſeemed not far from the verge of deſtruction. Livy tells us, that it was difficult to determine whether his conduct was more wonderful in proſperity or in adverſity. Notwithſtanding which, Bruttium being but a ſmall province, and many of its inhabitants being either forced into the ſervice, or forming themſelves into parties of banditti, ſo that a great part of it remained uncultivated, he found it a difficult matter to ſubſiſt there, eſpecially as no manner of ſupplies were ſent him from Carthage. The people there were as ſolicitous about preſerving their poſſeſſions in Spain, and as little concerned about the ſituation of affairs in Italy, as if Hannibal had met with an uninterrupted courſe of ſucceſs, and no diſaſter befallen him ſince he firſt entered that country.

142
The great progreſs of Scipio Africanus.

143
Mago lands in Italy.

All their ſolicitude, however, about the affairs of Spain, was to no purpoſe; their generals, one after another, were defeated by the Romans. They had indeed cut off the two Scipios; but found a much more formidable enemy in the young Scipio, afterwards ſurnamed *Africanus*. He overthrew them in conjunction with Maſiniſſa king of Numidia; and the latter thereafter abandoned their intereſt. Soon after, Syphax, king of the Maſæſylii, was likewiſe perſuaded to abandon their party. Scipio alſo gave the Spaniſh Reguli a great overthrow, and reduced the cities of New Carthage, Gades, and many other important places. At laſt the Carthaginians began to open their eyes when it was too late. Mago was ordered to abandon Spain, and ſail with all expedition to Italy. He landed on the coaſt of Liguria with an army of 12,000 foot and 2000 horſe; where he ſurpriſed Genoa, and alſo ſeized upon the town and port of Savo. A reinforcement was ſent him to this place, and new levies went on very briſkly in Liguria; but the opportunity was paſt, and could not be recalled. Scipio having carried all before him in Spain, paſſed over into Africa, where he met with no enemy capable

to

144 Scipio lands in Africa.

145 Mago and Hannibal recalled.

of oppoſing his progreſs. The Carthaginians, then, ſeeing themſelves on the brink of deſtruction, were obliged to recal their armies from Italy, in order to ſave their city. Mago, who had entered Inſubria, was defeated by the Roman forces there; and having retreated into the maritime parts of Liguria, met a courier who brought him orders to return directly to Carthage. At the ſame time, Hannibal was likewiſe recalled. When the meſſengers acquainted him with the ſenate's pleaſure, he expreſſed the utmoſt indignation and concern, groaning, gnaſhing his teeth, and ſcarce refraining from tears. Never baniſhed man, according to Livy, ſhowed ſo much regret in quitting his native country, as Hannibal did at going out of that of the enemy.

146 Hannibal's proceedings after his arrival in Africa.

147 He has an interview with Scipio.

The Carthaginian general was no ſooner landed in Africa, than he ſent out parties to get proviſions for the army, and buy horſes to remount the cavalry. He entered into a league with the regulus of the Arcacidæ, one of the Numidian tribes. Four thouſand of Syphax's horſe came over in a body to him; but as he did not think proper to repoſe any confidence in them, he put them all to the ſword, and diſtributed their horſes among his troops. Vermina, one of Syphax's ſons, and Macetulus, another Numidian prince, likewiſe joined him with a conſiderable body of horſe. Moſt of the fortreſſes in Maſiniſſa's kingdom either ſurrendered to him upon the firſt ſummons, or were taken by force. Narce, a city of conſiderable note there, he made himſelf maſter of by ſtratagem. Tychæus, a Numidian regulus, and faithful ally of Syphax, whoſe territories were famous for an excellent breed of horſes, reinforcing him alſo with 2000 of his beſt cavalry, Hannibal advanced to Zama, a town about five days journey diſtant from Carthage, where he encamped. He thence ſent out ſpies to obſerve the poſture of the Romans. Theſe being brought to Scipio, he was ſo far from inflicting any puniſhment upon them, which he might have done by the laws of war, that he commanded them to be led about the camp, in order to take an exact ſurvey of it, and then diſmiſſed them. Hannibal, admiring the noble aſſurance of his rival, ſent a meſſenger to deſire an interview with him: which, by means of Maſiniſſa, he obtained. The two generals, therefore, eſcorted by equal detachments of horſe, met at Nadagara, where, by the aſſiſtance of two interpreters, they held a private conference. Hannibal flattered Scipio in the moſt refined and artful manner, and expatiated upon all thoſe topics which he thought could influence that general to grant his nation a peace upon tolerable terms; amongſt other things, that the Carthaginians would willingly confine themſelves to Africa, ſince ſuch was the will of the gods, in order to procure a laſting peace, whilſt the Romans would be at liberty to extend their conqueſts to the remoteſt nations. Scipio anſwered, that Romans were not prompted by ambition, or any ſiniſter views, to undertake either the former or preſent war againſt the Carthaginians, but by juſtice and a proper regard for their allies. He alſo obſerved, that the Carthaginians had, before his arrival in Africa, not only made him the ſame propoſals, but likewiſe agreed to pay the Romans 5000 talents of ſilver, reſtore all the Roman priſoners without ranſom, and deliver up all their galleys. He inſiſted on the perfidious conduct of the Carthaginians, who had broke a truce concluded with them; and told him, that, ſo far from granting them more favourable terms, they ought to expect more rigorous ones; which if Hannibal would ſubmit to, a peace would enſue; if not, the deciſion of the diſpute muſt be left to the ſword.

148 The battle of Zama.

149 Hannibal totally routed.

This conferrence betwixt two of the greateſt generals the world ever produded, ending without ſucceſs, they both retired to their reſpective camps; where they informed their troops, that not only the fate of Rome and Carthage, but that of the whole world, was to be determined by them the next day. An engagement enſued*, in which, as Polybius informs us, the ſurpriſing military genius of Hannibal diſplayed itſelf in an extraordinary manner. Scipio likewiſe, according to Livy, paſſed a high encomium upon him, on account of his uncommon capacity in taking advantages, the excellent arrangement of his forces, and the manner in which he gave his orders during the engagement. The Roman general, indeed, not only approved his conduct, but openly declared that it was ſuperior to his own. Nevertheleſs, being vaſtly inferior to the enemy in horſe, and the ſtate of Carthage obliging him to hazard a battle with the Romans at no ſmall diſadvantage, Hannibal was utterly routed, and his camp taken. He fled firſt to Thon, and afterwards to Adrumentum, from whence he was recalled to Carthage; where being arrived, he adviſed his countrymen to conclude a peace with Scipio on whatever terms he thought proper to preſcribe.

* See *Zama*.

150 Peace concluded.

Thus was the ſecond war of the Carthaginians with the Romans concluded. The conditions of peace were very humiliating to the Carthaginians. They were obliged to deliver up all the Roman deſerters, fugitive ſlaves, priſoners of war, and all the Italians whom Hannibal had obliged to follow him. They alſo delivered up all their ſhips of war, except ten triremes, all their tame elephants, and were to train up no more of theſe animals for the ſervice. They were not to engage in any war without the conſent of the Romans. They engaged to pay to the Romans, in 50 years, 10,000 Euboic talents, at equal payments. They were to reſtore to Maſiniſſa all they had uſurped from him or his anceſtors, and to enter into an alliance with him. They were alſo to aſſiſt the Romans both by ſea and land, whenever they were called upon ſo to do, and never to make any levies either in Gaul or Liguria. Theſe terms appeared ſo intolerable to the populace that they threatened to plunder and burn the houſes of the nobility; but Hannibal having aſſembled a body of 6000 foot and 500 horſe at Marthama, prevented an inſurrection, and by his influence completed the accommodation.

151 Carthaginians oppreſſed by Maſiniſſa.

The peace between Carthage and Rome was ſcarcely ſigned, when Maſiniſſa unjuſtly made himſelf maſter of part of the Carthaginian dominions in Africa, under pretence that theſe formerly belonged to his family. The Carthaginians, through the villanous mediation of the Romans, found themſelves under a neceſſity of ceding theſe countries to that ambitious prince, and of entering into an alliance with him. The good underſtanding between the two powers continued for many years afterwards; but at laſt Maſiniſſa violated the treaties ſubſiſting betwixt him and the Carthaginian republic, and not a little contributed to its ſubverſion.

After the concluſion of the peace, Hannibal ſtill kept up his credit among his countrymen. He was intruſted with the command of an army againſt ſome neighbouring nations in Africa; but this being diſagreeable to the Romans, he was removed from it, and raiſed to the dignity of prætor in Carthage. Here he continued for ſome time, reforming abuſes, and putting the affairs of the republic into a better condition; but this likewiſe being diſagreeable to the Romans, he was obliged to fly to Antiochus king of Syria.

152
Hannibal flies to Antiochus.

After his flight, the Romans began to look upon the Carthaginians with a ſuſpicious eye; though to prevent every thing of this kind, the latter had ordered two ſhips to purſue Hannibal, had confiſcated his effects, raſed his houſe, and by a public decree declared him an exile.

153
Iniquitous proceedings of Maſinissa and the Romans.

Soon after, diſputes ariſing between the Carthaginians and Maſiniſſa, the latter, notwithſtanding the manifeſt iniquity of his proceedings, was ſupported by the Romans. That prince, graſping at further conqueſts, endeavoured to embroil the Carthaginians with the Romans, by aſſerting that the former had received ambaſſadors from Perſeus king of Macedon; that the ſenate aſſembled in the temple of Æſculapius in the night time, in order to confer with them; and that ambaſſadors had been diſpatched from Carthage to Perſeus, in order to conclude an alliance with him. Not long after this, Maſiniſſa made an irruption into the province of Tyſca, where he ſoon poſſeſſed himſelf of 70, or, as Appian will have it, 50 towns and caſtles. This obliged the Carthaginians to apply with great importunity to the Roman ſenate for redreſs, their hands being ſo tied up by an article in the laſt treaty, that they could not repel force by force, in caſe of an invaſion, without their conſent. Their ambaſſadors begged, that the Roman ſenate would ſettle once for all what dominions they were to have, that they might from thenceforth know what they had to depend upon; or, if their ſtate had any way offended the Romans, they begged that they would puniſh them themſelves, rather than leave them expoſed to the inſults and vexations of ſo mercileſs a tyrant. Then proſtrating themſelves on the earth, they burſt out into tears. But, nothwithſtanding the impreſſion their ſpeech made, the matter was left undecided; ſo that Maſiniſſa had liberty to purſue his rapines, as much as he pleaſed. But whatever villanous deſigns the Romans might have with regard to the republic of Carthage, they affected to ſhow a great regard to the principles of juſtice and honour. They therefore ſent Cato, a man famous for committing enormities under the ſpecious pretence of public ſpirit, into Africa, to accommodate all differences betwixt Maſiniſſa and the Carthaginians. The latter very well knew their fate, had they ſubmitted to ſuch a mediation; and therefore appealed to the treaty concluded with Scipio, as the only rule by which their conduct and that of their adverſary ought to be examined. This *unreaſonable* appeal ſo incenſed the righteous Cato, that he pronounced them a devoted people, and from that time reſolved upon their deſtruction. For ſome time he was oppoſed by Scipio Naſica; but the people of Carthage, knowing the Romans to be their inveterate enemies, and reflecting upon the iniquitous treatment they had met with from them ever ſince the commencement of their diſputes with Maſiniſſa, were under great apprehenſions of a viſit from them. To prevent a rupture as much as poſſible, by a decree of the ſenate, they impeached Aſdrubal general of the army, and Carthalo, commander of the auxiliary forces, together with their accomplices, as guilty of high treaſon, for being the authors of the war againſt the king of Numidia. They ſent a deputation to Rome, to diſcover what ſentiments were entertained there of their late conduct, and to know what ſatisfaction the Romans required. Theſe meſſengers meeting with a cold reception, others were diſpatched, who returned with the ſame ſucceſs. This made the unhappy citizens of Carthage believe that their deſtruction was reſolved upon; which threw them into the utmoſt deſpair. And indeed they had but too juſt grounds for ſuch a melancholy apprehenſion, the Roman ſenate now diſcovering an inclination to fall in with Cato's meaſures. About the ſame time, the city of Utica, being the ſecond in Africa, and famous for its immenſe riches, as well as its equally commodious and capacious port, ſubmitted to the Romans. Upon the poſſeſſion of ſo important a fortreſs, which, by reaſon of its vicinity to Carthage, might ſerve as a place of arms in the attack of that city, the Romans declared war againſt the Carthaginians without the leaſt heſitation.

154
War declared by the Romans againſt Carthage.

In conſequence of this declaration, the conſuls M. Manlius Nepos, and L. Marcius Cenſorinus, were diſpatched with an army and fleet to begin hoſtilities with the utmoſt expedition. The land forces conſiſted of 80,000 foot and 4000 choſen horſe; and the fleet of 50 quinqueremes, beſides a vaſt number of tranſports. The conſuls had ſecret orders from the ſenate not to conclude the operations but by the deſtruction of Carthage, without which, it was pretended, the republic could not but look upon all her poſſeſſions as inſecure. Purſuant to the plan they had formed, the troops were firſt landed at Lilybæum in Sicily, from whence, after receiving a proper refreſhment, it was propoſed to tranſport them to Utica.

155
Ambaſſadors ſent to Rome.

The anſwer brought by the laſt ambaſſadors to Carthage had not a little alarmed the inhabitants of that city. But they were not yet acquainted with the reſolutions taken at Rome. They therefore ſent freſh ambaſſadors thither, whom they inveſted with full powers to act as they thought proper for the good of the republic, and even to ſubmit themſelves without reſerve to the pleaſure of the Romans. But the moſt ſenſible perſons among them did not expect any great ſucceſs from this condeſcenſion, ſince the early ſubmiſſion of the Uticans had rendered it infinetly leſs meritorious than it would have been before. However, the Romans ſeemed to be in ſome meaſure ſatisfied with it, ſince they promiſed them their liberty, the enjoyment of their laws, and in ſhort, every thing that was dear and valuable to them. This threw them into a tranſport of joy, and they wanted words to extol the moderation of the Romans.

156
The Romans demand 300 hoſtages.

But the ſenate immediately daſhed all their hopes, by acquainting them that this favour was granted upon condition that they would ſend 300 young Carthaginian noblemen of the firſt diſtinction to the prætor Fabius at Lilybæum, within the ſpace of 30 days, and comply with all the orders of the conſuls. Theſe hard terms filled the whole city with inexpreſſible grief: but the hoſtages were delivered; and as they arrived at Lilybæum before the 30 days were expired, the ambaſſadors were not without hopes of ſoftening their hard-hearted enemy. But the conſuls only told them, that upon their arrival at Utica they ſhould learn the further orders of the republic.

157 and all the Carthaginian arms, military machines, &c.

The miniſters no ſooner received intelligence of the Roman fleet appearing off Utica, than they repaired thither, in order to know the fate of their city. The conſuls however did not judge it expedient to communicate all the commands of the republic at once, leſt they ſhould appear ſo harſh and ſevere, that the Carthaginians would have refuſed to comply with them. They firſt, therefore, demanded a ſufficient ſupply of corn for the ſubſiſtence of their troops. Secondly, That they ſhould deliver up into their hands all the triremes they were then maſters of. Thirdly, That they ſhould put them in poſſeſſion of all their military machines. And, fourthly, That they ſhould immediately convey all their arms into the Roman camp.

158 They command them to deſtroy their city.

159 The Carthaginians reſolve to ſuſtain a ſiege.

160 They make new arms.

As care was taken that there ſhould be a convenient interval of time betwixt every one of theſe demands, the Carthaginians found themſelves enſnared, and could not reject any one of them, though they ſubmitted to the laſt with the utmoſt reluctance and concern. Cenſorinus, now imagining them incapable of ſuſtaining a ſiege, commanded them to abandon their city, or, as Zonarias will have it, to demoliſh it; permitting them to build another 80 ſtadia from the ſea, but without walls or fortifications. This terrible decree threw the ſenate and every one elſe into deſpair; and the whole city became a ſcene of horror, madneſs, and confuſion. The citizens curſed their anceſtors for not dying gloriouſly in the defence of their country, rather than concluding ſuch ignominious treaties of peace, that had been the cauſe of the deplorable condition to which their poſterity was then reduced. At length, when the firſt commotion was a little abated, the ſenators aſſembled, and reſolved to ſuſtain a ſiege. They were ſtripped of their arms and deſtitute of proviſions; but deſpair raiſed their courage, and made them find out expedients. They took care to ſhut the gates of the city; and gathered together on the ramparts great heaps of ſtones, to ſerve them inſtead of arms in caſe of a ſurpriſe. They took the malefactors out of priſon, gave the ſlaves their liberty, and incorporated them in the militia. Aſdrubal was recalled, who had been ſentenced to die only to pleaſe the Romans; and he was invited to employ 20,000 men he had raiſed againſt his country in defence of it. Another Aſdrubal was appointed to command in Carthage; and all ſeemed reſolute, either to ſave their city or periſh in its ruins. They wanted arms; but, by order of the ſenate, the temples, porticoes, and all public buildings, were turned into workhouſes, where men and women were continually employed in making arms. As they encouraged one another in their work, and loſt no time in procuring to themſelves the neceſſaries of life, which were brought to them at ſtated hours, they every day made 144 bucklers, 300 ſwords, 1000 darts, and 500 lances and javelins. As to baliſtæ and catapultæ, they wanted proper materials for them; but their induſtry ſupplied that defect. Where iron and braſs were wanting, they made uſe of ſilver and gold, melting down the ſtatues, vaſes, and even the utenſils of private families; for, on this occaſion, even the moſt covetous became liberal. As tow and flax were wanting to make cords for working the machines, the women, even thoſe of the firſt rank, freely cut off their hair and dedicated it to that uſe. Without the walls, Aſdrubal employed the troops in getting together proviſions, and conveying them ſafe into Carthage; ſo that there was as great plenty there as in the Roman camp.

161 The city attacked by the Romans, who are repulſed.

162 Part of the Roman fleet deſtroyed.

In the mean time the conſuls delayed drawing near to Carthage, not doubting but the inhabitants, whom they imagined deſtitue of neceſſaries to ſuſtain a ſiege, would, upon cool reflection, ſubmit; but at length, finding themſelves deceived in their expectation, they came before the place and inveſted it. As they were ſtill perſuaded that the Carthaginians had no arms, they flattered themſelves that they ſhould eaſily carry the city by aſſault. Accordingly they approached the walls in order to plant their ſcaling ladders; but to their great ſurpriſe they diſcovered a prodigious multitude of men on the ramparts, ſhining in the armour they had newly made. The legionaries were ſo terrified at this unexpected ſight, that they drew back, and would have retired, if the conſuls had not led them on to the attack; which, however, proved unſucceſsful; the Romans, in ſpite of their utmoſt efforts, being obliged to give over the enterpriſe, and lay aſide all thoughts of taking Carthage by aſſault. In the mean time, Aſdrubal, having collected from all places ſubject to Carthage a prodigious number of troops, came and encamped within reach of the Romans, and ſoon reduced them to great ſtraits for want of proviſions. As Marcius, one of the Roman conſuls, was poſted near a marſh, the exhalations of the ſtagnating waters, and the heat of the ſeaſon, infected the air, and cauſed a general ſickneſs among his men. Marcius, therefore, ordered his fleet to draw as near the ſhore as poſſible, in order to tranſport his troops to a healthier place. Aſdrubal being informed of this motion, ordered all the old barks in the harbour to be filled with faggots, tow, ſulphur, bitumen, and other combuſtible materials; and then, taking advantage of the wind, which blew towards the enemy, let them drive upon their ſhips, which were for the moſt part conſumed. After this diſaſter, Marcius was called home to preſide at the elections; and the Carthaginians looking upon the abſence of one of the conſuls to be a good omen, made a briſk ſally in the night; and would have ſurpriſed the conſul's camp, had not Æmilianus, with ſome ſquadrons, marched out of the gate oppoſite to the place where the attack was made, and, coming round, fell unexpectedly on their rear, and obliged them to return in diſorder to the city.

Aſdrubal had poſted himſelf under the walls of a city named Nepheris, 24 miles diſtant from Carthage, and ſituated on a high mountain, which ſeemed inacceſſible on all ſides. From thence he made incurſions into the neighbouring country, intercepted the Roman convoys, fell upon their detachments ſent out to forage, and even ordered parties to inſult the conſular army in their camp. Hereupon the conſul reſolved to drive the Carthaginian from this advantageous poſt, and ſet out for Nepheris. As he drew near the hills, Aſdrubal ſuddenly appeared at the head of his army in order of battle, and fell upon the Romans with incredible fury. The conſular army ſuſtained the attack with great reſolution; and Aſdrubal retired in good order 163 The Roman army in great danger, is ſaved by Scipio Æmilianus. to his poſt, hoping the Romans would attack him there. But the conſul, being now convinced of his danger, reſolved to retire. This Aſdrubal no ſooner perceived, than he ruſhed down the hill, and falling upon the enemy's rear, cut a great number of them in pieces. The whole Roman army was now ſaved by the bravery of Scipio Æmilianus. At the head of 300 horſe, he ſuſtained the attack of all the forces commanded by Aſdrubal, and covered the legions, while they paſſed a river in their retreat before the enemy. Then he and his companions threw themſelves into the ſtream, and ſwam acroſs it. When the army had croſſed the river, it was perceived that four manipuli were wanting; and ſoon after they were informed that they had retired to an eminence, where they reſolved to ſell their lives as dear as poſſible. Upon this news Æmilianus, taking with him a choſen body of horſe, and proviſions for two days, croſſed the river, and flew to the aſſiſtance of his countrymen. He ſeized a hill over againſt that on which the four manipuli were poſted; and, after ſome hours repoſe, marched againſt the Carthaginians who kept them inveſted; fell upon them at the head of his ſquadron with the boldneſs of a man determined to conquer or die; and, in ſpite of all oppoſition, opened a way for his fellow-ſoldiers to eſcape. On his return to the army, his companions, who had given him over for loſt, carried him to his quarters in a kind of triumph; and the manipuli he had ſaved gave him a crown of *gramen*. By theſe and ſome other exploits, Æmilianus gained ſuch reputation, that Cato, who is ſaid never to have commended any body before, could not refuſe him the praiſes he deſerved; and is ſaid to have foretold that Carthage would never be reduced till Scipio Æmilianus was employed in that expedition.

The next year, the war in Africa fell by lot to the conſul L. Calpurnius Piſo; and he continued to employ Æmilianus in ſeveral important enterpriſes, in 164 He gains over the Carthaginian general of horſe. which he was attended with uncommon ſucceſs. He took ſeveral caſtles; and in one of his excurſions, found means to have a private conference with Phameas, general, under Aſdrubal, of the Carthaginian cavalry, and brought him over, together with 2200 of his horſe, to the Roman intereſt. Under the conſul Calpurnius Piſo himſelf, however, the Roman arms were unſucceſsful. He inveſted Clupea; but was obliged to abandon the enterpriſe, with the loſs of a great number of men killed by the enemy in their ſallies. From this place he went to vent his rage on a city newly built, and thence called *Neapolis*, which profeſſed a ſtrict neutrality, and had even a ſafeguard from the Romans. The conſul, however, plundered the place, and ſtripped the inhabitants of all their effects. After this he laid ſiege to *Hippagreta*, which employed the Roman fleet and army the whole ſummer; and, on the approach of winter, the conſul retired to Utica, without performing a ſingle action worth notice during the whole campaign.

165 He is choſen conſul.

The next year Scipio Æmilianus was choſen conſul, and ordered to paſs into Africa; and, upon his arrival, the face of affairs was greatly changed. At the time of his entering the port of Utica, 3500 Romans were in great danger of being cut in pieces before Carthage. Theſe had ſeized Megalia, one of the ſuburbs of the city: but as they had not furniſhed themſelves with proviſions to ſubſiſt there, and could not retire, being cloſely inveſted on all ſides by the enemy's troops, the prætor Mancinus, who commanded this detachment, ſeeing the danger into which he had brought himſelf, diſpatched a light boat to Utica, to acquaint the Romans there with his ſituation. Æmilianus received this letter a few hours after his landing; and immediately flew to the relief of the beſieged Romans, obliged the Carthaginians to retire within their walls, and ſafely conveyed his countrymen to Utica. Having then drawn together all the troops, Æmilianus applied himſelf wholly to the ſiege of the capital.

166 Cruelties of Aſdrubal.

His firſt attack was upon Megalia; which he carried by aſſault, the Carthaginian garriſon retiring into the citadel of Byrſa. Aſdrubal, who had commanded the Carthaginian forces in the field, and was now governor of the city, was ſo enraged at the loſs of Megalia, that he cauſed all the Roman captives taken in the two years the war laſted, to be brought upon the ramparts, and thrown headlong, in the ſight of the Roman army, from the top of the wall; after having, with an exceſs of cruelty, commanded their hands and feet to be cut off, and their eyes and tongues to be torn out. He was of a temper remarkably inhuman; and it is ſaid that he even took pleaſure in ſeeing ſome of theſe unhappy men flayed alive. Æmilianus, in the mean time, was buſy in drawing lines of circumvallation and contravallation acroſs the neck of land which joined the iſthmus on which Carthage ſtood to the 167 Carthage blocked up by ſea and land. continent. By this means, all the avenues on the land ſide of Carthage being ſhut up, the city could receive no proviſions that way. His next care was to raiſe a mole in the ſea, in order to block up the old port, the new one being already ſhut up by the Roman fleet; and this great work he effected with immenſe labour. The mole reached from the weſtern neck of land, of which the Romans were maſters, to the entrance of the port; and was 90 feet broad at the bottom, and 80 at the top. The beſieged, when the Romans firſt began this ſurpriſing work, laughed at the attempt; but were no leſs alarmed than ſurpriſed, when they beheld a vaſt mole appearing above water, and by that means the port rendered inacceſſible to ſhips, and quite uſeleſs. 168 The beſieged dig a wide baſon. Prompted by deſpair, however, the Carthaginians, with incredible and almoſt miraculous induſtry, dug a new baſon, and cut a paſſage into the ſea, by which they could receive the proviſions that were ſent them by their troops in the field. With the ſame diligence and expedition, they fitted out a fleet of 50 triremes; which, to the great ſurpriſe of the Romans, appeared ſuddenly advancing into the ſea through this new canal, and even ventured to give the enemy battle. The action laſted the whole day, with little advantage on either ſide. The day after, the conſul endeavoured to make himſelf maſter of a terrace which covered the city on the ſide next the ſea; and on this occaſion the 169 They ſet fire to the Roman machines. beſieged ſignalized themſelves in a moſt remarkable manner. Great numbers of them, naked and unarmed, went into the water in the dead of the night, with unlighted torches in their hands; and having, partly by ſwimming, partly by wading, got within reach of the

Roman engines, they ſtruck fire, lighted their torches and threw them with fury againſt the machines. The ſudden appearance of theſe naked men, who looked like ſo many monſters ſtarted up out of the ſea, ſo terrified the Romans who guarded the machines, that they began to retire with the utmoſt confuſion. The conſul, who commanded the detachment in perſon, and had continued all night at the foot of the terrace, endeavoured to ſtop his men, and even ordered thoſe who fled to be killed. But the Carthaginians, perceiving the confuſion the Romans were in, threw themſelves upon them like ſo many wild beaſts; and having put them to flight only with their torches, they ſet fire to the machines, and entirely conſumed them.---This, however, did not diſcourage the conſul; he renewed the attack a few days after, carried the terrace by aſſault, and lodged 4000 men upon it. As this was an important poſt, becauſe it pent in Carthage on the ſea ſide, Æmilianus took care to fortify and ſecure it againſt the ſallies of the enemy; and then, winter approaching, he ſuſpended all further attacks upon the place till the return of good weather. During the winter ſeaſon, however, the conſul was not inactive. The Carthaginians had a very numerous army under the command of one Diogenes, ſtrongly encamped near Nepheris, whence convoys of proviſions were ſent by ſea to the beſieged, and brought into the new baſon.

170
Vaſt ſlaughter of the Carthaginians.

To take Nepheris, therefore, was to deprive Carthage of her chief magazine. This Æmilianus undertook, and ſucceeded in the attempt. He firſt forced the enemy's intrenchments, put 70,000 of them to the ſword, and made 10,000 priſoners; all the inhabitants of the country, who could not retire to Carthage, having taken refuge in this camp. After this he laid ſiege to Nepheris, which was reduced in 22 days. Aſdrubal being diſheartened by the defeat of the army, and touched with the miſery of the beſieged, now reduced to the utmoſt extremity for want of proviſions, offered to ſubmit to what conditions the Romans pleaſed, provided the city was ſpared; but this was abſolutely refuſed.

171
Cotho taken.

Early in the ſpring, Æmilianus renewed the ſiege of Carthage; and in order to open himſelf a way into the city, he ordered Lælius to attempt the reduction of Cotho, a ſmall iſland which divided the two ports. Æmilianus himſelf made a falſe attack on the citadel, in order to draw the enemy thither. This ſtratagem had the deſired effect: for the citadel being a place of the greateſt importance, moſt of the Carthaginians haſtened thither, and made the utmoſt efforts to repulſe the aggreſſors; but in the mean time Lælius having, with incredible expedition, built a wooden bridge over the channel which divided Cotho from the iſthmus, entered the iſland, ſcaled the walls of the fortreſs which the Carthaginians had built there, and made himſelf maſter of that important poſt.

172
Romans enter the city.

The proconſul, who was engaged before Byrſa, no ſooner underſtood, by the loud ſhouts of the troops of Lælius, that he had made himſelf maſter of Cotho, than he abandoned the falſe attack, and unexpectedly fell on the neighbouring gate of the city, which he broke down, notwithſtanding the ſhowers of darts that were inceſſantly diſcharged upon his men from the ramparts. As night coming on prevented him from proceeding farther, he made a lodgment within the gate, and waited there for the return of day, with a deſign to advance through the city to the citadel, and attack it on that ſide, which was but indifferently fortified. Purſuant to this deſign, at day break, he ordered 4000 freſh troops to be ſent from his camp; and having ſolemnly devoted to the infernal gods the unhappy Carthaginians, he began to advance at the head of his men through the ſtreets of the city, in order to attack the citadel. Having advanced to the market place, he found that the way to the citadel lay through three exceeding ſteep ſtreets. The houſes on both ſides were very high, and filled with the Carthaginians, who overwhelmed the Romans as they advanced with darts and ſtones; ſo that they could not proceed till they had cleared them. To this end Æmilianus in perſon, at the head of a detatchment, attacked the firſt houſe, and made himſelf maſter of it ſword in hand. His example was followed by the officers and ſoldiers, who went on from houſe to houſe, putting all they met with to the ſword. As faſt as the houſes were cleared on both ſides, the Romans advanced in order of battle towards the citadel; but met with a vigorous reſiſtance from the Carthaginians, who on this occaſion behaved with uncommon reſolution. From the market place to the citadel, two bodies of men fought their way every ſtep, one above on the roofs of the houſes, the other below in the ſtreets. The ſlaughter was inexpreſſibly great and dreadful. The air rung with ſhrieks and lamentations. Some were cut in pieces, others threw themſelves down from the tops of the houſes; ſo that the ſtreets were filled with dead and mangled bodies.

173
Which is ſet on fire.

But the deſtruction was yet greater when the proconſul commanded fire to be ſet to that quarter of the town which lay next to the citadel. Incredible multitudes, who had eſcaped the ſwords of the enemy, periſhed in the flames, or by the fall of the houſes. After the fire, which laſted ſix days, had demoliſhed a ſufficient number of houſes, Æmilianus ordered the rubbiſh to be removed, and a large area to be made, where all the troops might have room to act. Then he appeared with his whole army before Byrſa; which ſo terrified the Carthaginians, who had fled thither for refuge, that firſt of all 25,000 women, and then 30,000 men, came out of the gates in ſuch a condition as moved pity. They threw themſelves proſtrate before the Roman general, aſking no favour but life. This was readily granted, not only to them but to all that were in Byrſa except the Roman deſerters, whoſe number amounted to 900.

174
Cruelty and cowardice of Aſdrubal.

Aſdrubal's wife earneſtly entreated her huſband to ſuffer her to join the ſuppliants, and carry with her to the proconſul her two ſons who were as yet very young; but the barbarian denied her requeſt, and rejected her remonſtrances with menaces. The Roman deſerters, ſeeing themſelves excluded from mercy, reſolved to die ſword in hand, rather than deliver themſelves up to the vengeance of their countrymen. Then Aſdrudal, finding them all reſolved to defend themſelves to the laſt breath, committed to their care his wife and children; after which, he in a moſt cowardly and mean ſpirited manner, came and privately threw himſelf at the conqueror's feet. The Carthaginians in the citadel no ſooner underſtood that their commander had abandoned the place, than they threw open the gates, and put the Romans in poſſeſſion of Byrſa. They had now no enemy to contend with but the 900 deſerters, who, being reduced to deſpair, retreated into the temple of Æſculapius, which was as a ſecond temple within the firſt. There the proconſul attacked them; and theſe unhappy wretches, finding there was no way to eſcape, ſet fire to the temple. As the flames ſpread, they retreated from one part of the building to another, till they got to the roof. There Aſdrubal's wife appeared in her beſt apparel, and having uttered the moſt bitter imprecations againſt her huſband, whom ſhe ſaw ſtanding below with Æmilianus, "Baſe coward (ſaid ſhe), the mean things thou haſt done to ſave thy life ſhall not avail thee: thou ſhalt die this inſtant, at leaſt in thy two children." Having thus ſpoken, ſhe ſtabbed both the infants with a dagger; and while they were yet ſtruggling for life, threw them both from the top of the temple, and then leaped down after them into the flames.

175
Aſdrubal's wife deſtroys herſelf and two children.

176
Carthage plundered,

Æmilianus delivered up the city to be plundered, but in the manner preſcribed by the Roman military law. The ſoldiers were allowed to appropriate to themſelves all the furniture, utenſils, and braſs money, they ſhould find in private houſes; but all the gold and ſilver, the ſtatues, pictures, &c. were reſerved to be put into the hands of the quæſtors. On this occaſion the cities of Sicily, which had been often plundered by the Carthaginian armies, recovered a number of ſtatues, pictures, and other valuable monuments; among the reſt the famous brazen bull, which Phalaris had ordered to be caſt, and uſed as the chief inſtrument of his cruelty, was reſtored to the inhabitants of Agrigentum. As Æmilianus was greatly inclined to ſpare what remained of this ſtately metropolis, he wrote to the ſenate on the ſubject, from whom he received the following orders: 1. The city of Carthage, with Byrſa and Megalia, ſhall be entirely deſtroyed, and no traces of them left. 2. All the cities that have lent Carthage any aſſiſtance ſhall be diſmantled. 3. The territories of thoſe cities which have declared for the Romans ſhall be enlarged with lands taken from the enemy. 4. All the lands between Hippo and Carthage ſhall be divided among the inhabitants of Utica. 5. All the Africans of the Carthaginian ſtate, both men and women, ſhall pay an annual tribute to the Romans at ſo much per head. 6. The whole country, which was ſubject to the Carthaginian ſtate, ſhall be turned into a Roman province, and be governed by a prætor, in the ſame manner as Sicily. Laſtly, Rome ſhall ſend commiſſioners into Africa, there to ſettle jointly with the proconſul the ſtate of the new province. Before Æmilianus deſtroyed the city, he performed theſe religious ceremonies which were required on ſuch occaſions: he firſt ſacrificed to the gods, and then cauſed a plough to be drawn round the walls of the city. After this, the towers, ramparts, walls, and all the works which the Carhaginians had raiſed in the courſe of many ages, and at a vaſt expence, were levelled with the ground; and laſtly, fire was ſet to the edifices of the proud metropolis, which conſumed them all, not a ſingle houſe eſcaping the flames. Though the fire began in all quarters at the ſame time, and burnt with incredible fury, it continued for 17 days before all the buildings were conſumed.

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and utterly deſtroyed.

Thus fell Carthage, about 146 years before the birth of Chriſt; a city whoſe deſtruction ought to be attributed more to the intrigues of an abandoned faction, compoſed of the moſt profligate part of its citizens than to the power of its rival. The treaſure which Æmilianus carried off, even after the city had been delivered up to be plundered by the ſoldiers, was immenſe, Pliny making it to amount to 4,470,000 pounds weight of ſilver. The Romans ordered Carthage never to be inhabited again, denouncing dreadful imprecations againſt thoſe who, contrary to this prohibition, ſhould attempt to rebuild any part of it, eſpecially Byrſa and Megalia. Notwithſtanding this, however, about 24 years after, C. Gracchus, tribune of the people, in order to ingratiate himſelf with them, undertook to rebuild it; and, to that end conducted thither a colony of 6000 Roman citizens. The workmen, according to Plutarch, were terrified by many unlucky omens at the time they were tracing the limits and laying the foundations of the new city; which the ſenate being informed of, would have ſuſpended the attempt. But the tribune, little affected with ſuch preſages, continued to carry on the work, and finiſhed it in a few days. From hence it is probable that only a ſlight kind of huts were erected; but whether Gracchus executed his deſign, or the work was entirely diſcontinued, it is certain that Carthage was the firſt Roman colony ever ſent out of Italy. According to ſome authors, Carthage was rebuilt by Julius Cæſar; and Strabo, who flouriſhed in the reign of Tiberius, affirms it in his time to have been equal, if not ſuperior, to any other city in Africa. It was looked upon as the capital of Africa for ſeveral centuries after the commencement of the Chriſtian era. Maxentius laid it in aſhes about the ſixth or ſeventh year of Conſtantine's reign. Genſeric, king of the Vandals, took it A. D. 439; but about a century afterwards it was re-annexed to the Roman empire by the renowned Beliſarius. At laſt the Saracens, under Mohammed's ſucceſſors, towards the cloſe of the ſeventh century, ſo completely deſtroyed it, that there are now ſcarce any traces remaining.

178
Rebuilt.

179
Utterly deſtroyed by the Saracens.

At the commencement of the third Punic war, Carthage appears to have been one of the firſt cities in the world. It was ſeated on a peninſula 360 ſtadia or 45 miles in circumference, joined to the continent by an iſthmus 23 ſtadia or three miles and a furlong in breadth. On the weſt ſide there projected from it a long tract of land half a ſtadium broad; which ſhooting out into the ſea, ſeparated it from a lake or moraſs, and was ſtrongly fortified on all ſides by rocks and a ſingle wall. In the middle of the city ſtood the citadel of Byrſa, having on the top of it a temple ſacred to Æſculapius, ſeated upon rocks on a very high hill, to which the aſcent was by 60 ſteps. On the ſouth ſide the city was ſurrounded by a triple wall, 30 cubits high; flanked all round by parapets and towers, placed at equal diſtances of 480 feet. Every tower had its foundation ſunk 32 feet deep, and was four ſtories high, though the walls were but two: they were arched; and, in the lower part, correſponding in depth with the foundation above-mentioned, were ſtalls large enough to hold 300 elephants, with their fodder, &c. Over theſe were ſtalls and other conveniences for 4000 horſes; and there was likewiſe room for lodging 20,000 foot and 4000 cavalry, without in

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Its ancient grandeur.

in the leaſt incommoding the inhabitants. There were two harbours, ſo diſpoſed as to have a communication with one another. They had one common entrance 70 feet broad, and ſhut up with chains. The firſt was appropriated to the merchants; and included in it a vaſt number of places of refreſhment, and all kinds of accommodation for ſeamen. The ſecond, as well as the iſland of Cothon, in the midſt of it, was lined with large quays, in which were diſtinct receptacles for ſecuring and ſheltering from the weather 220 ſhips of war. Over theſe were magazines of all ſorts of naval ſtores. The entrance into each of theſe receptacles was adorned with two marble pillars of the Ionic order; ſo that both the harbour and iſland repreſented on each ſide two magnificent galleries. Near this iſland was a temple of Apollo, in which was a ſtatue of the god all of maſſy gold; and the inſide of the temple all lined with plates of the ſame metal, weighing 1000 talents. The city was 23 miles in circumference, and at the time we ſpeak of contained 700,000 inhabitants. Of their power we may have ſome idea, by the quantity of arms they delivered up to the Roman conſuls. The whole army was aſtoniſhed at the long train of carts loaded with them, which were thought ſufficient to have armed all Africa. At leaſt it is certain, that on this occaſion were put into the hands of the Romans 2000 catapultæ, 200,000 complete ſuits of armour, with an innumerable quantity of ſwords, darts, javelins, arrows, and beams armed with iron, which were thrown from the ramparts by the baliſtæ.

The character tranſmitted of the Carthaginians is extremely bad; but we have it only on the authority of the Romans, who being their implacable enemies, cannot be much relied upon. As to their religion, manners, &c. being much the ſame with the Phœnicians, of which they were a colony, the reader is referred for an account of theſe things to the article PHOENICIA.

On the ruins of Carthage there now ſtands only a ſmall village called *Melcha*. The few remains of Carthage conſiſt only of ſome fragments of walls, and 17 ciſterns for the reception of rain water.

There are three eminences, which are ſo many maſſes of fine marbles pounded together, and were in all probability the ſites of temples and other diſtinguiſhed buildings. The preſent ruins are by no means the remains of the ancient city deſtroyed by the Romans; who after taking it, entirely eraſed it, and ploughed up the very foundations: ſo truly they adhered to the well-known advice perpetually inculcated by Cato the Elder, *Delenda eſt Carthago*. It was again rebuilt by the Gracchi family, who conducted a colony to re-people it: and continually increaſing in ſplendour, it became at length the capital of Africa under the Roman emperors. It ſubſiſted near 700 years after its firſt demolition, until it was entirely deſtroyed by the Saracens in the beginning of the 7th century.

It is a ſingular circumſtance that the two cities of Carthage and Rome ſhould have been built juſt oppoſite one to the other; the bay of Tunis and the mouth of the Tiber being in a direct line.

> *Littora littoribus contraria, fluctibus undas,*
> *Arma armis.* VIRG. Æn. iv. 627.

New CARTHAGE, a conſiderable town of Mexico, in the province of Coſta Rica. It is a very rich trading place. W. Long. 86. 7. N. Lat. 9. 5.

CARTHAGENA, a province of South America, and one of the moſt conſiderable in New Caſtile, on account of the great trade carried on by the capital; for the country itſelf is neither fertile, rich, nor populous. The capital city, called likewiſe *Carthagena*, is ſituated in W. Long. 77. N. Lat. 11. on a ſandy iſland, by moſt writers called a peninſula; which forming a narrow paſſage on the ſouth-weſt, opens a communication with that called *Tierra Bomba*, as far as *Bocca Chica*. The little iſland which now joins them was formerly the entrance of the bay; but it having been filled up by orders of the court, Boca Chica became the only entrance: this, however, has been filled up ſince the attempt of Vernon and Wentworth, and the old paſſage again opened. On the north ſide the land is ſo narrow, that before the wall was begun, the diſtance from ſea to ſea was only 35 toiſes; but afterwards enlarging, it forms another iſland on this ſide; ſo that, excepting thoſe two places, the whole city is entirely ſurrounded by ſalt water. To the eaſtward it has a communication, by means of a wooden bridge, with a large ſuburb called *Xemani*, built on another iſland, which is alſo joined to the continent by a bridge of the ſame materials. The fortifications both of the city and ſuburbs are built after the modern manner, and lined with freeſtone; and, in time of peace, the garriſon conſiſts of ten companies of 77 men each, beſides militia. The city and ſuburbs are well laid out, the ſtreets ſtraight, broad, uniform, and well paved. All the houſes are built of ſtone or brick, only one ſtory high, well contrived, neat, and furniſhed with balconies and lattices of wood, which is more durable in that climate than iron, the latter being ſoon corroded by the acrimonious quality of the atmoſphere. The climate is exceedingly unhealthy. The Europeans are particularly ſubject to the terrible diſeaſe called the *black vomit*, which ſweeps off multitudes annually on the arrival of the galleons. It ſeldom continues above three or four days; in which time the patient is either dead or out of danger, and if he recovers, is never ſubject to a return of the ſame diſtemper. —This diſeaſe has hitherto foiled all the art of the Spaniſh phyſicians; as has alſo the leproſy, which is very common here. At Carthagena, likewiſe, that painful tumour in the legs, occaſioned by the entrance of the *Dracunculus* or Guinea-worm, is very common and troubleſome. Another diſorder peculiar to this country, and to Peru, is occaſioned by a little inſect called *Nigua*, ſo extremely minute as ſcarce to be viſible to the naked eye. This inſect breeds in the duſt, inſinuates itſelf into the ſoles of the feet and the legs, piercing the ſkin with ſuch ſubtility, that there is no being aware of it, before it has made its way to the fleſh. If it is perceived in the beginning, it is extracted with little pain; but having once lodged its head, and pierced the ſkin, the patient muſt undergo the pain of an inciſion, without which a nidus would be formed, and a multitude of inſects ingendered, which would ſoon overſpread the foot and leg. One ſpecies of the *nigua* is venomous; and when it enters the toe, an inflammatory ſwelling, greatly reſembling a venereal bubo, takes place in the groin.

CARTHAGENA, a ſea port town of Spain, in the kingdom of Murcia, and capital of a territory of the ſame name; built by Aſdrubal, a Carthaginian general, and named after Carthage. It has the beſt harbour in all Spain, but nothing elſe very conſiderable; the biſhop's ſee being transferred to Toledo. In 1706 it was taken by Sir John Leake: but the duke of Berwick retook it afterwards. W. Long. 0. 58. N. Lat. 37. 36.

CARTHAMUS. See BOTANY *Index*. The carthamus tinctorius is at preſent cultivated in many parts of Europe, and alſo in the Levant, from whence great quantities of it are annually imported into Britain for the purpoſes of dying and painting. The good quality of this commodity is in the colour, which is of a bright ſaffron hue: and in this the Britiſh carthamus very often fails; for if there happens much rain during the time the plants are in flower, the flowers change to a dark or dirty yellow, as they likewiſe do if the flowers are gathered with any moiſture remaining upon them.—The ſeeds of carthamus have been celebrated as a cathartic; but they operate very ſlowly, and for the moſt part diſorder the ſtomach and bowels, eſpecially when given in ſubſtance: triturated with diſtilled aromatic waters, they form an emulſion leſs offenſive, yet inferior in efficacy to the more common purgatives. They are eaten by a ſpecies of Egyptian parrot, which is very fond of them; to other birds or beaſts they would prove a mortal poiſon.

CARTHUSIANS, a religious order, founded in the year 1080, by one Brudo. The Carthuſians, ſo called from the deſert of *Chartreux*, the place of their inſtitution, are remarkable for the auſterity of their rule. They are not to go out of their cells, except to church, without leave of their ſuperior, nor ſpeak to any perſon without leave. They muſt not keep any portion of their meat or drink till next day; their beds are of ſtraw, covered with a felt; their clothing two hair cloths, two cowls, two pair of hoſe, and a cloak, all coarſe. In the refectory, they are to keep their eyes on the diſh, their hands on the table, their attention on the reader, and their hearts fixed on God. Women are not allowed to come into their churches. It is computed that there are 172 houſes of Carthuſians; whereof five are of *nuns*, who practice the ſame auſterities as the monks. They are divided into 16 provinces. each of which has two viſitors. There have been ſeveral canonized ſaints of this order, four cardinals, 70 archbiſhops and biſhops, and a great many very learned writers.

CARTHUSIAN *Powder*, the ſame with kermes mineral. See KERMES.

CARTILAGE, in *Anatomy*, a body approaching to the nature of bones; but lubricous, flexible, and elaſtic. See ANATOMY *Index*.

Brit. Zool. iii. 75. CARTILAGINOUS, in *Ichthyology*, a title given to all fiſh whoſe muſcles are ſupported by cartilages inſtead of bones; and comprehends the ſame genera of fiſh to which Linnæus has given the name of *amphibia nantes*: but the word *amphibia* ought properly to be confined to ſuch animals as inhabit both elements; and can live, without any inconvenience, for a conſiderable time, either on land or in water; ſuch as tortoiſes, frogs, and ſeveral ſpecies of lizards; and among the quadrupeds, hippopotami, &c. &c.

Many of the cartilaginous fiſh are viviparous, being excluded from an egg. which is hatched within them. The egg conſiſts of a white and a yolk; and is lodged in a caſe formed of a thick tough ſubſtance, not unlike ſoftened horn: ſuch are the eggs of the *ray* and *ſhark* kinds. Some again differ in this reſpect, and are oviparous: ſuch is the *ſturgeon*, and others.

They breathe either through certain apertures beneath, as in the *rays*; on their ſides, as in the *ſharks*, &c.; or on the top of the head, as in the *pipe fiſh*: for they have not covers to their gills like the bony fiſh.

CARTMEL, a town of Lancaſhire in England. It is ſeated among the hills called Cartmel-fells, not far from the ſea, and near the river Kent; adorned with a very handſome church, built in the form of a croſs like a cathedral. The market is well ſupplied with corn, ſheep, and fiſh. W. Long. 2. 43. N. Lat. 54. 15.

CARTON, or CARTOON, in *Painting*, a deſign drawn on ſtrong paper, to be afterwards chalked through, and transferred on the freſh plaſter of a wall, to be painted in freſco. It is alſo uſed for a deſign coloured, for working in moſaic, tapeſtry, &c. The word is from the Italian *cartoni* (*carta* "paper," and *oni* "large,") denoting many ſheets of paper paſted on canvas. on which large deſigns are made. whether coloured or with chalks only. Of theſe many are to be ſeen at Rome, particularly by Domenichino. Thoſe by Andrea Mantegna, which are at Hampton Court, were made for paintings in the old ducal palace at Mantua. But the moſt famous performances of this ſort are,

The *Cartoons of Raphael*, ſo deſervedly applauded throughout Europe by all authors of refined taſte, and all true admirers of the art of deſign. for their various and matchleſs merit, particularly with regard to the invention, and to the great and noble expreſſion of ſuch a variety of characters, countenances, and moſt expreſſive attitudes, as they are differently affected and properly engaged, in every compoſition. Theſe cartoons are ſeven in number, and form only a ſmall part of the ſacred hiſtorical deſigns executed by this great artiſt, while engaged in the chambers of the Vatican under the auſpices of Popes Julius II. and Leo X. When finiſhed, they were ſent to Flanders, to be copied in tapeſtry, for adorning the pontifical apartments; which tapeſtries were not ſent to Rome till ſeveral years after the deceaſe of Raphael, and even in all probability were not finiſhed and ſent there before the terrible ſack of that city in the time of Clement VII. when Raphael's ſcholars had fled from thence, and none left to inquire after the original cartoons, which lay neglected in the ſtorerooms of the manufactory. The great revolution alſo which followed in the Low Countries prevented their being noticed amidſt the entire neglect of the works of art. It was therefore a moſt fortunate circumſtance that theſe ſeven eſcaped the wreck of the others, which were torn in pieces, and remain diſperſed as fragments in different collections. Theſe ſeven were purchaſed by Rubens for Charles I. and they have been ſo roughly handled from the firſt, that holes were pricked for the weavers to pounce the outlines, and other parts almoſt cut through in tracing alſo. In this ſtate perhaps they as fortunately eſcaped the ſale amongſt the royal collection, by the diſproportioned appraiſement of theſe ſeven at 300l. and the nine pieces, being the Triumph of Julius Cæſar, by Andrea Mantegna, appraiſed at 1000l. They ſeem to have been taken ſmall notice of till King William built a gallery, purpoſely to receive them at Hampton Court; whence they were moved, on their ſuffering from damps, to the Queen's Palace. They are now at Windſor Caſtle, and open to public inſpection.

CARTOUCHE, in *Architecture* and *Sculpture*, an ornament repreſenting a ſcroll of paper. It is uſually a flat member, with wavings to repreſent ſome inſcription, device, cipher, or ornament of armoury. They are, in architecture, much the ſame as modillions; only theſe are ſet under the cornice in wainſcotting, and thoſe under the cornice at the eaves of a houſe.

Cartouche, in the military art, a caſe of wood, about three inches thick at the bottom, girt with marline, holding about four hundred muſket balls, beſides ſix or eight balls of iron, of a pound weight, to be fired out of a hobit, for the defence of a paſs, &c.

A cartouche is ſometimes made of a globular form, and filled with a ball of a pound weight; and ſometimes it is made for the guns, being of a ball of half or quarter a pound weight, according to the nature of the gun, tied in form of a bunch of grapes, on a tompion of wood, and coated over. Theſe were made in the room of partridge-ſhot.

CARTRIDGE, in the military art, a caſe of paſteboard or parchment, holding the exact charge of a fire-arm. Thoſe for muſkets, carabines, and piſtols, hold both the powder and ball for the charge; and thoſe of cannon and mortars are uſually in caſes of paſteboard or tin, ſometimes of wood, half a foot long, adapted to the caliber of the piece.

Cartridge-*Box*, a caſe of wood or turned iron, covered with leather, holding a dozen muſket cartridges. It is worn upon a belt, and hangs a little lower than the right pocket hole.

CARTWRIGHT, William, an eminent divine and poet, born at Northway, near Tewkſbury, in Glouceſterſhire, in September 1611. He finiſhed his education at Oxford; afterwards went into holy orders, and became a moſt florid preacher in the univerſity. In 1642, he had the place of ſuccentor in the church of Saliſbury; and, in 1643, was choſen junior proctor in the univerſity. He was alſo metaphyſical reader there. Wit, judgement, elocution, a graceful perſon and behaviour, occaſioned that encomium of him from Dean Fell, "That he was the utmoſt that man could come to." He was an expert linguiſt; an excellent orator; and at the ſame time was eſteemed an admirable poet. There are extant of his, four plays, and ſome poems. He died in 1643, aged 33.

CARVAGE, (*carvagium*), the ſame with Carrucage.

Henry III. is ſaid to have taken carvage, that is, two marks of ſilver of every knight's fee, towards the marriage of his ſiſter Iſabella to the emperor. Carvage could only be impoſed on tenants *in capite*.

Carvage alſo denotes a privilege whereby a man is exempted from the ſervice of carrucage.

CARUCATURIUS, in ancient law books, he that held land in ſoccage, or by plough tenure.

CARUCATE. See Carrucate.

CARVER, a cutter of figures or other devices in wood. See Carving.

Carvers anſwer to what the Romans called *ſculptores*, who were different from *cælatores*, or engravers, as theſe laſt wrought in metal.

Carver is alſo an officer of the table, whoſe buſineſs is to cut up the meat, and diſtribute it to the gueſts. The word is formed from the Latin *carptor*, which ſignifies the ſame. The Romans alſo called him *carpus*, ſometimes *ſciſſor*, *ſcindendi magiſter*, and *ſtructor*.

In the great families at Rome, the carver was an officer of ſome figure. There were maſters to teach them the art regularly, by means of figures of animals cut in wood. The Greeks alſo had their carvers, called διατροι, q. d. *deribitores*, or *diſtributors*. In the primitive times, the maſter of the feaſt carved for all his gueſts. Thus in Homer, when Agamemnon's ambaſſadors were entertained at Achilles's table, the hero himſelf carved the meat. Of latter times, the ſame office on ſolemn occaſions was executed by ſome of the chief men of Sparta. Some derive the cuſtom of diſtributing to every gueſt his portion, from thoſe early ages when the Greeks firſt left off feeding on acorns, and learned the uſe of corn: The new diet was ſo great a delicacy, that to prevent the gueſts from quarrelling about it, it was found neceſſary to make a fair diſtribution.

In Scotland, the king has a hereditary carver in the family of Anſtruther.

CARUI, or Carvi, in *Botany*. See Carum, Botany *Index*.

CARVING, in a general ſenſe, the art or act of cutting or faſhioning a hard body, by means of ſome ſharp inſtrument, eſpecially a chiſſel. In this ſenſe carving includes ſtatuary and engraving, as well as cutting in wood.

Carving, in a more particular ſenſe, is the art of engraving or cutting figures in wood. In this ſenſe *carving*, according to Pliny, is prior both to ſtatuary and painting.

To carve a figure or deſign, it muſt be firſt drawn or paſted on the wood; which done, the reſt of the block not covered by the lines of the deſign, are to be cut away with little narrow-pointed knives. The wood fitteſt for the uſe is that which is hard, tough, and cloſe, as beech, but eſpecially box: to prepare it for drawing the deſign on, they waſh it over with white lead tempered in water; which better enables it either to bear ink or the crayon, or even to take the impreſſion by chalking. When the deſign is to be paſted on the wood, this whitening is omitted, and they content themſelves with ſeeing the wood well planed. Then wiping over the printed ſide of the figure with gum tragacanth diſſolved in water they clap it ſmooth on the wood, and let it dry: which done, they wet it ſlightly over, and fret off the ſurface of the paper gently, till all the ſtrokes of the figure appear diſtinctly. This done, they fall to cutting or carving, as above.

CARUM. See Botany *Index*.

CARUNCULA, or Caruncle, in *Anatomy*, a term denoting a little piece of fleſh, and applied to ſeveral parts of the human body. Thus, CaruncuLæ *Myrtiformes*, in *Anatomy*, fleſhy knobs about the ſize of a myrtle berry, ſuppoſed to owe their origin to the breaking of the hymen. See Anatomy *Index*.

Caruncles, in the urethra, proceeding from a gonorrhœa, or an ulceration of the urethra, may be reduced by introducing the Bougie.

CARUS, a ſudden deprivation of ſenſe and motion, affecting the whole body. See Medicine *Index*.

Carus, *Marcus Aurelius*, was raiſed from a low ſtation, by his great merit, to be emperor of Rome in 282. He ſhowed himſelf worthy of the empire; ſubdued its enemies; and gave the Romans a proſpect of happy days, when he was unfortunately killed by lightning in 284.

CARWAR, a town of Aſia, on the coaſt of Malabar in the Eaſt Indies, and where the Eaſt India Company have a factory, fortified with two baſtions. The valleys about it abound in corn and pepper, which laſt is the beſt in the Eaſt Indies. The woods on the mountains abound with quadrupeds, ſuch as tigers, wolves, monkeys, wild hogs, deers, elks, and a ſort of beeves of a prodigious ſize. The religion of the natives is Paganiſm; and they have a great many ſtrange and ſuperſtitious cuſtoms. E. Long. 73. 7. N. Lat. 15. 0.

CARYA, -Æ, (Stephanus); *Caryæ, -arum*, (Pauſanias); a town of Laconia, between Sparta and the borders of Meſſenia; where ſtood a temple of Diana, thence called *Caryatis, -idis;* whoſe annual feſtival, called *Carya, -orum*, was celebrated by Spartan virgins with dances. An inhabitant, *Caryates*, and *Caryatis*. *Caryatis apis* a Laconian bee, (Stephanus).

Caryæ, *-arum*, in *Ancient Geography*, a place in Arcadia, towards the borders of Laconia. Whether from this of Arcadia, or that of Laconia, the *Columnæ caryatides* of Vitruvius and Pliny (which were ſtatues of matrons in ſtoles or long robes) took the appellation, is diſputed.

CARY Lucius, Lord Viſcount Falkland, was born in Oxfordſhire, about the year 1610; a young nobleman of great abilities and accompliſhments. About the time of his father's death in 1633, he was made gentleman of the privy chamber to King Charles I. and afterwards ſecretary of ſtate. Before the aſſembling of the long parliament, he had devoted himſelf to literature, and every pleaſure which a fine genius, a generous diſpoſition, and an opulent fortune, could afford: when called into public life, he ſtood foremoſt in all attacks on the high prerogatives of the crown; but when civil convulſions came to an extremity, and it was neceſſary to chooſe a ſide, he tempered his zeal, and defended the limited powers that remained to monarchy. Still anxious, however, for his country, he ſeems to have dreaded equally the proſperity of the royal party, and that of the parliament; and among his intimate friends, often ſadly reiterated the word *peace*. This excellent nobleman freely expoſed his perſon for the king in all hazardous enterpriſes, and was killed in the 34th year of his age at the battle of Newberry. In Wellwood's Memoirs we are told, that whilſt he was with the king at Oxford, his majeſty went one day to ſee the public library, where he was ſhown among other books a Virgil, nobly printed, and exquiſitely bound. The Lord Falkland, to divert the king, would have his majeſty make a trial of his fortune by the Sortes Virgilianæ, an uſual kind of divination in ages paſt, made by opening a Virgil. The king opening the book, the paſſage which happened to come up, was that part of Dido's imprecation againſt Æneas, iv. 615, &c. which is thus tranſlated by Dryden:

> " Oppreſs'd with numbers in th' unequal field,
> " His men diſcourag'd, and himſelf expell'd;
> " Let him for ſuccour ſue from place to place.
> " Torn from his ſubjects and his ſon's embrace." &c.

King Charles ſeeming concerned at this accident, the Lord Falkland, who obſerved it, would likewiſe try his own fortune in the ſame manner, hoping he might fall upon ſome paſſage that could have no relation to his caſe, and thereby divert the king's thoughts from any impreſſion the other might make upon him: but the place Lord Falkland ſtumbled upon was yet more ſuited to his deſtiny than the other had been to the king's; being the following expreſſions of Evander, upon the untimely death of his ſon Pallas, Æn. xi. 152.

> " O Pallas? thou haſt failed thy plighted word,
> " To fight with caution not to tempt the ſword.
> " I warn'd thee, but in vain; for well I knew
> " What perils youthful ardour would purſue;
> " That boiling blood would carry thee too far;
> " Young as thou wert in dangers, raw to war.
> " O curſt eſſay of arms, diſaſtrous doom,
> " Prelude of bloody fields and fights to come!"

He wrote ſeveral things both poetical and political; and in ſome of the king's declarations, ſuppoſed to be penned by Lord Falkland, we find the firſt regular definition of the Engliſh conſtitution that occurs in any compoſition publiſhed by authority. His predeceſſor, the firſt Viſcount Cary, was ennobled for being the firſt who gave King James an account of Queen Elizabeth's death.

Cary, *Robert*, a learned Engliſh chronologer, born in Devonſhire about the year 1615. On the Reſtoration, he was preferred to the archdeaconry of Exeter, but on ſome pretext was ejected in 1664, and ſpent the reſt of his days at his rectory of Portlemoth, where he died in 1688. He publiſhed *Palælogia Chronica*, a chronology of ancient times, in three parts, didactical, apodeictical, and canonical; and tranſlated the hymns of the church into Latin verſe.

CARYTES, in antiquity, a feſtival in honour of Diana ſurnamed *Caryatis*, held at Caryum, a city of Laconia. The chief ceremony was a certain dance ſaid to have been invented by Caſtor and Pollux, and performed by the virgins of the place. During Xerxes's invaſion, the Laconians not daring to appear and celebrate the cuſtomary ſolemnity, to prevent incurring the anger of the goddeſs by ſuch an intermiſſion, the neighbouring ſwains are ſaid to have aſſembled and ſung paſtorals or *bucoliſmi*, which is ſaid to have been the origin of *bucolic* poetry.

CARYATIDES, or Cariates. See Architecture.

CARYL, Joseph, a divine of the laſt century, bred at Oxford, and ſome time preacher to the ſociety of Lincoln's-Inn, an employment he filled with much applauſe. He became a frequent preacher before the long parliament, a licenſer of their books, one of the aſſembly of divines, and one of the triers for the approbation of miniſters; in all which capacities he ſhowed himſelf a man of conſiderable parts and learning, but with great zeal againſt the king's perſon and cauſe. On the reſtoration of Charles II. he was ſilenced by the act of uniformity, and lived privately in London, where, beſides other works, he diſtinguiſhed himſelf by a laborious *Expoſition of the Book of Job;* and died in 1672.

CARYLL, John, a late Engliſh poet, was of the Roman Catholic perſuaſion, being ſecretary to Queen Mary the wife of James II. and one who followed the fortunes of his abdicating maſter; who rewarded him, firſt with knighthood, and then with the honorary titles of Earl Caryll and Baron Dartford. How long he continued in that ſervice is not known; but he was in England in the reign of Queen Anne, and recommended the ſubject of the "Rape of the Lock" to Mr Pope, who at its publication addreſſed it to him.' He was alſo the intimate friend of Pope's "Unfortunate Lady." He was the author of two plays: 1. "The Engliſh Princeſs, or the Death of Richard III. 1667," 4to.; 2. "Sir Salomon, or the Cautious Coxcomb. 1671," 4to.; and in 1700, he publiſhed "The Pſalms of David, tranſlated from the Vulgate," 12mo. In Tonſon's edition of Ovid's Epiſtles, that of "Briſeis to Achilles" is ſaid to be by Sir John Caryll; and in Nichols's Select Collection of Miſcellany Poems, vol. ii. p. 1. the firſt eclogue of Virgil is tranſlated by the ſame ingenious poet. He was living in 1717, and at that time muſt have been a very old man. See three of his letters in the "Additions to Pope," vol. ii. p. 114.

CARYOCAR, in *Botany;* a genus of the tetragynia order, belonging to the polyandria claſs of plants. The calyx is quinquepartite, the petals five, the ſtyles more frequently four. The fruit is a plum, with nucleuſſes, and four furrows netted.

CARYOPHYLLÆI, in *Botany*, the name of a very numerous family or order in Linnæus's Fragments of a Natural Method; containing, beſides the claſs of the ſame name in Tournefort, many other plants, which from their general appearance ſeem pretty nearly allied to it. The following are the genera, viz. Agroſtema, Cacubalus, Dianthus, Drypis, Gypſophilia, Lychnis, Saponaria, Silene, Velazia, Alſine, Arenaria, Bufonia, Ceraſtium, Cherleria, Glinus, Holoſteum, Loeflingia, Mochringia, Polycarpon, Sagina, Spergula, Stellaria, Minuartia, Mollugo, Ortegia, Pharnaceum, Queria. All the plants of this order are herbaceous, and moſtly annual. Some of the creeping kinds do not riſe an inch, and the talleſt exceed not ſeven or eight feet. See Botany, *Natural Orders*.

CARYOPHYLLUS, the Pink, in *Botany*. See Dianthus.

Caryophyllus, the Clove tree. See Botany *Index*.

The caryophyllus aromaticus is a native of the Molucca iſlands, particularly of Amboyna, where it is principally cultivated. The clove tree reſembles, in its bark the olive, and is about the height of the laurel, which it alſo reſembles in its leaves. No verdure is ever ſeen under it. It has a great number of branches, at the extremities of which, are produced vaſt quantities of flowers, that are firſt white, then green, and at laſt pretty red and hard. When they arrive at this degree of maturity, they are, properly ſpeaking, *cloves*. As they dry, they aſſume a dark yellowiſh caſt; and when gathered, become of a deep brown. The ſeaſon for gathering the cloves is from October to February. The boughs of the trees are then ſtrongly ſhaken, or the cloves beat down with long reeds. Large cloths are ſpread to receive them, and they are afterwards either dried in the ſun or in the ſmoke of the bamboo cane. The cloves which eſcape the notice of thoſe who gather them, or are purpoſely left upon the tree, continue to grow till they are about an inch in thickneſs; and theſe falling off, produce new plants, which do not bear in leſs than eight or nine years. Thoſe which are called *mother cloves* are inferior to the common ſort; but are preſerved in ſugar by the Dutch; and in long voyages, eaten after their meals, to promote digeſtion.

The clove, to be in perfection, muſt be full ſized, heavy, oily, and eaſily broken; of a fine ſmell, and of a hot aromatic taſte, ſo as almoſt to burn the throat. It ſhould make the fingers ſmart when handled, and leave an oily moiſture upon them when preſſed. In the Eaſt Indies, and in ſome parts of Europe, it is ſo much admired as to be thought an indiſpenſible ingredient in almoſt every diſh. It is put into their food, liquors, wines, and enters likewiſe the compoſition of their perfumes. Conſidered as medicines, cloves are very hot ſtimulating aromatics, and poſſeſs in an eminent degree the general virtues of ſubſtances of this claſs. Their pungency reſides in their reſin; or rather in a combination of reſin with eſſential oil: for the ſpirituous extract is very pungent; but if the oil and the reſin contained in this extract are ſeparated from each other by diſtillation, the oil will be very mild; and any pungency which it does retain, proceeds from ſome ſmall portion of adhering reſin, and the remaining reſin will be inſipid. No plant, or part of any plant, contains ſuch a quantity of oil as cloves do. From 16 ounces Newman obtained by diſtillation two ounces and two drachms, and Hoffman obtained an ounce and a half of oil from two ounces of the ſpice. The oil is ſpecifically heavier than water. Cloves acquire weight by imbibing water; and this they will do at ſome conſiderable diſtance. The Dutch, who trade in cloves, make a conſiderable advantage by knowing this ſecret. They ſell them always by weight; and when a bag of cloves is ordered, they hang it, for ſeveral hours before it is ſent in, over a veſſel of water, at about two feet diſtance from the ſurface. This will add many pounds to the weight, which the unwary purchaſer pays for on the ſpot. This is ſometimes practiſed in Europe, as well as in the Spice Iſlands; but the degree of moiſture muſt be more carefully watched in the latter; for there a bag of cloves will, in one night's time, attract ſo much water, that it may be preſſed out of them by ſqueezing them with the hand.

The clove tree is never cultivated in Europe. At Amboyna the Company have alloted the inhabitants 4000 parcels of land, on each of which they were at firſt allowed, and about the year 1720 compelled, to plant about 125 trees, amounting in all to 500,000. Each of theſe trees produces annually, on an average, more than two pounds of cloves; and conſequently the collective produce muſt weigh more than a million

lion. The cultivator is paid with the ſpecie that is conſtantly returned to the Company, and receives ſome unbleached cottons which are brought from Coromandel.

CARYOTA. See Botany *Index*.

CASA, in ancient and middle-age writers, is uſed to denote a cottage or houſe.

Casa *Santa*, denotes the chapel of the holy virgin at Loretto. The *Santa Caſa* is properly the houſe, or rather chamber, in which the bleſſed virgin is ſaid to have been born, where ſhe was betrothed to her ſpouſe Joſeph, where the angel ſaluted her, the Holy Ghoſt overſhadowed her, and by conſequence where the Son of God was conceived or incarnated. Of this building the Catholics tell many wonderful ſtories too childiſh to tranſcribe. The *Santa Caſa*, or holy chamber, conſiſts of one room, forty-four ſpans long, eighteen broad, and twenty three high. Over the chimney, in a niche, ſtands the image called the great *Madona* or Lady, four feet high, made of cedar, and, as they ſay, wrought by St Luke, who was a carver as well as a phyſician. The mantle or robe ſhe has on, is covered with innumerable jewels of ineſtimable value. She has a crown, given her by Louis XIII. of France, and a little crown for her ſon.

CASAL, a ſtrong town of Italy in Montferrat, with a citadel and a biſhop's ſee. It was taken by the French from the Spaniards in 1640; and the duke of Mantua ſold it to the French in 1681. In 1695 it was taken by the allies, who demoliſhed the fortifications; but the French retook it, and fortified it again. The king of Sardinia became maſter of it in 1706, from whom the French took it in 1745; however the king of Sardinia got poſſeſſion again in 1746. It is ſeated on the river Po, in E. Long. 8. 37. N. Lat. 54. 7.

Casal-*Maggiore*, a ſmall ſtrong town of Italy, in the duchy of Milan, ſeated on the river Po. E. Long. 11. 5. N. Lat. 45. 6.

CASA NOVA, Marc Antony, a Latin poet, born at Rome, ſucceeded particularly in epigrams. The poems he compoſed in honour of the illuſtrious men of Rome are alſo much eſteemed. He died in 1527.

CASAN, a conſiderable town of Aſia, and capital of a kingdom of the ſame name in the Ruſſian empire, with a ſtrong caſtle, a citadel, and an archbiſhop's ſee. The country about it is very fertile in all ſorts of fruits, corn, and pulſe. It carries on a great trade in furs, and furniſhes wood for the building of ſhips. The kingdom of Caſan is bounded on the north by Permia, on the eaſt by Siberia, on the ſouth by the river Wolga, and on the weſt by the province of Moſcow. E. Long. 53. 25. N. Lat. 55. 38.

CASAS, Bartholomew de las, biſhop of Chiapa, diſtinguiſhed for his humanity and zeal for the converſion of the Indians, was born at Seville in 1474; and went with his father who ſailed to America with Chriſtopher Columbus in 1493. At his return to Spain, he embraced the ſtate of an eccleſiaſtic, and obtained a curacy in the iſland of Cuba: but ſome time after quitted his cure in order to procure liberty for the Indians, whom he ſaw treated by the Spaniards in the moſt cruel and barbarous manner, which naturally gave them an unconquerable averſion to Chriſtianity. Bartholomew exerted himſelf with extraordinary zeal, for 50 years together, in his endeavours to perſuade the Spaniards that they ought to treat the Indians with equity and mildneſs; for which he ſuffered a number of perſecutions from his countrymen. At laſt the court, moved by his continual remonſtrances, made laws in favour of the Indians, and gave orders to the governors to obſerve them, and ſee them executed *. He died at Madrid in 1566, aged 92. He wrote ſeveral works, which breathe nothing but humanity and virtue. The principal of them are 1. An account of the deſtruction of the Indies. 2. Several treatiſes in favour of the Indies, againſt Dr Sepulveda, who wrote a book to juſtify the inhuman barbarities committed by the Spaniards. 3. A very curious, and now ſcarce, work in Latin, on this queſtion, "Whether kings or princes can, conſiſtently with conſcience, or in virtue of any right or title, alienate their ſubjects, and place them under the dominion of another ſovereign?"

CASATI, Paul, a learned Jeſuit, born at Placentia in 1617, entered early among the Jeſuits; and after having taught mathematics and divinity at Rome, was ſent into Sweden to Queen Chriſtina, whom he prevailed on to embrace the Popiſh religion. He wrote, 1. *Vacuum proſcriptum.* 2. *Terra machinis mota.* 3. *Mechanicorum, libri octo.* 4. *De Igne Diſſertationes,* which is much eſteemed. 5. *De Angelis Diſputatio Theolog.* 6. *Hydroſtaticæ Diſſertationes.* 7. *Opticæ Diſputationes.* It is remarkable that he wrote this treatiſe on optics at 88 years of age, and after he was blind. He alſo wrote ſeveral books in Italian.

CASAUBON, Isaac, was born at Geneva in 1559; and Henry IV. appointed him his library keeper in 1603. After this prince's death, he went to England with Sir Henry Wotton, ambaſſador from King James I. where he was kindly received, and engaged in writing againſt Baronius's annals. He died not long after this, in 1614; and was interred in Weſtminſter-abbey, where a monument was erected to him. He was greatly ſkilled in the Greek, and in criticiſm; publiſhed ſeveral valuable commentaries; and received the higheſt eulogiums from all his cotemporaries.

Casaubon, *Meric*, a ſon of the preceding, was born at Geneva in 1599. He was bred at Oxford, and took the degree of maſter of arts in 1621. The ſame year he publiſhed a book in defence of his father againſt the calumnies of certain Roman Catholics, which gained him the favour of King James I. and a conſiderable reputation abroad. He was made prebendary of Canterbury by Archbiſhop Laud. In the beginning of the civil war he loſt all his ſpiritual promotions, but ſtill continued to publiſh excellent works. Oliver Cromwell, then lieutenant-general of the parliament's forces, would have employed his pen in writing the hiſtory of the late war; but he declined it, owning that this ſubject would oblige him to make ſuch reflections as would be ungrateful, if not injurious, to his Lordſhip. Notwithſtanding this anſwer, Cromwell, ſenſible of his worth, ordered three or four hundred pounds to be paid him by a bookſeller in London, whoſe name was Cromwell, on demand, without requiring from him any acknowledgment of his benefactor. But this offer he rejected, though his circumſtances were then mean. At the ſame time it was propoſed by his friend Mr

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* See the article *Mexico*.

Greaves, who belonged to the library at St James's, that, if Caſaubon would gratify Cromwell in the requeſt above mentioned, all his father's books, which were then in the royal library, having been purchaſed by King James, ſhould be reſtored to him, and a penſion of 300l. a year paid to the family as long as the youngeſt ſon of Dr Caſaubon ſhould live; but this alſo was refuſed. He likewiſe refuſed handſome offers from Chriſtina queen of Sweden, being determined to ſpend the remainder of his life in England. At the Reſtoration he recovered all his preferments, and continued writing till his death in 1671. He was the author of an Engliſh tranſlation of Marcus Aurelius Antoninus's Meditations, and of Lucius Florus; editions of ſeveral of the claſſics, with notes; a treatiſe of uſe and cuſtom; a treatiſe of enthuſiaſm; with many other works; and he left a number of MSS. to the univerſity of Oxford.

CASURINA. See BOTANY *Index*.

CASCADE, a ſteep fall of water from a higher into a lower place. The word is French, formed of the Italian *caſcata*, which ſignified the ſame; of *caſcaro*, "to fall," and that from the Latin *cadere*.

Caſcades are either natural, as that at Tivoli, &c. or artificial, as thoſe of Verſailles, &c. and either falling with a gentle deſcent, as thoſe of Sceaux; or in form of a buffet, as at Trianon; or down ſteps, in form of a perron, as at St Cloud; or from baſon to baſon, &c.

CASCAIS, a town of Eſtremadura in Portugal, ſituated at the mouth of the river Tagus, 17 miles eaſt of Liſbon. W. Long. 10. 15. N. Lat. 38. 40.

CASCARILLA. See CLUTIA and CROTON.

CASE, among grammarians, implies the different inflections or terminations of nouns, ſerving to expreſs the different relations they bear to each other; and to the things they repreſent. See GRAMMAR.

CASE alſo denotes a receptacle for various articles; as a caſe of knives, of lancets, of piſtols, &c.

CASE, in printing, a large flat oblong frame placed aſlope, divided into ſeveral compartments or little ſquare cells; in each of which are lodged a number of types or letters of the ſame kind, whence the compoſitor takes them out, each as he needs it, to compoſe his matter. See PRINTING.

CASE is alſo uſed for a certain numerous quantity of divers things. Thus a caſe of crown glaſs contains uſually 24 tables, each table being nearly circular, and about three feet ſix inches diameter; of Newcaſtle glaſs, 35 tables; of Normandy glaſs, 25.

CASE-*Hardening of Iron*, is a ſuperficial converſion of that metal into ſteel, by the ordinary method of converſion, namely, by cementation with vegetable or mineral coals. This operation is generally practiſed upon ſmall pieces of iron wrought into tools and inſtruments to which a ſuperficial converſion is ſufficient; and it may be performed conveniently by putting the pieces of iron to be caſe-hardened, together with the cement, into an iron box, which is to be cloſely ſhut and expoſed to a red heat during ſome hours. By this cementation a certain thickneſs from the ſurface of the iron will be converted into ſteel, and a proper hardneſs may be afterwards given by ſudden extinction of the heated pieces of converted iron in a cold fluid. See STEEL.

CASE *Shot*, in the military art, muſket balls, ſtones, old iron, &c. put into caſes, and ſhot out of great guns.

CASEMENT, or CASEMATE, in *Architecture*, a hollow moulding, which ſome architects make one-ſixth of a circle, and others one fourth.

CASEMENT is alſo uſed in building, for a little moveable window, uſually within a larger, being made to open or turn on hinges.

CASERN, in fortification, lodgings built in garriſon towns, generally near the rampart, or in the waſte places of the town, for lodging ſoldiers of the garriſon. There are uſually two beds in each caſern for ſix ſoldiers to lie, who mount the guard alternately; the third part being always on duty.

CASERTA, an epiſcopal town of Italy, in the kingdom of Naples, and in the Terra de Lavoro, with the title of a duchy, ſeated at the foot of a mountain of the ſame name, in E. Long. 15. 5. N. Lat. 41. 5.

CASES, PETER-JAMES, of Paris, the moſt eminent painter of the French ſchool. The churches of Paris and of Verſailles abound with his works. He died in 1754, aged 79.

CASH, in a commercial ſtyle, ſignifies the ſtock or ready money which a merchant or other perſon has in his preſent diſpoſal to negotiate; ſo called from the French term *caiſſe*, i. e. "cheſt or coffer," for the keeping of money.

M. Savary ſhows that the management of the caſh of a company is the moſt conſiderable article, and that whereon its good or ill ſucceſs depends.

CASH-*Book*. See BOOK-KEEPING.

CASHEL, or CASHIL, a town of Ireland in the county of Tipperary, and province of Munſter, with an archbiſhop's ſee. The ruins of the old cathedral teſtify its having been an extenſive as well as handſome Gothic ſtructure, boldly towering on the celebrated rock of Caſhel, which taken together form a magnificent object, and bear honourable teſtimony to the labour and ingenuity, as well as the piety and zeal, of its former inhabitants. It is ſeen at a great diſtance, and in many directions. Adjoining it are the ruins of the chapel of Cormac M'Culinan, at once king and archbiſhop of Caſhel, ſuppoſed to have been the firſt ſtone building in Ireland; and ſeems, by its rude imitation of pillars and capitals, to have been copied after the Grecian architecture, and long to have preceded that which is uſually called *Gothic*. Cormac M'Culinan was a prince greatly celebrated by the Iriſh hiſtorians for his learning, piety, and valour. He wrote, in his native language, a hiſtory of Ireland, commonly called the *Pſalter of Caſhel*, which is ſtill extant, and contains the moſt authentic account we have of the annals of the country to that period, about the year 900. On the top of the rock of Caſhel, and adjoining the cathedral, is a lofty round tower, which proudly defied the too ſucceſsful attempts of Archbiſhop Price, who in this century unroofed and thereby demoliſhed the ancient cathedral founded by St Patrick. In the choir are the monuments of Myler Magrath, archbiſhop of this ſee, in the reign of Queen Elizabeth, aud ſome other curious remains of antiquity. Caſhel was formerly the royal ſeat and metropolis of the kings of Munſter; and on the aſcent to the cathedral is a large ſtone on which every new king of Munſter was, as the inhabitants report from tradition, formerly proclaimed. Caſhel is at preſent but ſmall to what we may ſuppoſe it to have been in ancient days. The archbiſhop's palace is a fine building. Here is a very handſome market houſe, a ſeſſions houſe, the county infirmary, a charter ſchool for twenty boys and the ſame number of girls, and a very good barrack for two companies of foot. Dr Agar finiſhed a very elegant church which was begun by his predeceſſor. W. Long. 7. 36. N. Lat. 52. 16.

CASHEW nut. See Anacardium. Botany *Index*.

CASHIER, the caſh-keeper; he who is charged with the receiving and paying the debts of a ſociety.—In the generality of foundations, the caſhier is called *treaſurer*.

Cashiers *of the Bank*, are officers who ſign the notes that are iſſued out, examine and mark them when returned for payment, &c.

CASHMIRE, a province of Aſia in the dominions of the Mogul. It is ſituated at the extremity of Hindoſtan, northward of Lahore, and is bounded on the one ſide by a ridge of the great Caucaſus, and on the other by the little Tartarian Thibet and Moultan. The extent of it is not very conſiderable; but being girt in by a zone of hills, and elevated very conſiderably above an arid plain, which ſtretches many miles around it, the ſcenes which it exhibits are wild and pictureſque. Rivers, hills, and valleys, charmingly diverſify the landſcape. Here, Mr Sullivan * informs us, a caſcade ruſhes from a foaming precipice; there a tranquil ſtream glides placidly along; the tinkling rill, too, ſounds amidſt the groves; and the feathered choriſters ſing the ſong of love, cloſe ſheltered in the glade.

At what time Caſhmire came under the dominion of the Mogul government, and how long, and in what manner it was independent, before it was annexed to the territories of the houſe of Timur, are points that are beyond our preſent purpoſe. Though inconſiderable as to its revenues, it was uniformly held in the higheſt eſtimation by the emperors of Hindoſtan. Thither they repaired in the plenitude of their greatneſs, when the affairs of ſtate would admit of their abſence; and there they diveſted themſelves of form, and all the oppreſſive ceremony of ſtate. The royal manner of travelling to Caſhmire was grand, though tedious and unwieldy, and ſhowed, in an eminent degree, the ſplendour and magnificence of an eaſtern potentate. Aurengzebe, we are told, ſeldom began his march to that country, for a march certainly it was to be called, without an eſcort of 80,000 or 100,000 fighting men, beſides the gentlemen of his houſehold, the attendants of his ſeraglio, and moſt of his officers of ſtate. Theſe all continued with him during the time he was on the road, which generally was a month; but no ſooner was he arrived at the entrance of thoſe aerial regions, than, with a ſelect party of friends, he ſeparated from the reſt of his retinue, and with them aſcended the defiles which led him to his Eden.

The temperature of the air of Caſhmire, elevated as it is ſo much above the adjoining country, together with the ſtreams which continually pour from its mountains, enables the huſbandman to cultivate with ſucceſs the ſoil he appropriates to agriculture; whilſt the gardener's labour is amply repaid in the abundant produce of his fruit. In ſhort, nature wears her gayeſt clothing in this enchanting ſpot. The rivers ſupply the inhabitants with almoſt every ſpecies of fiſh; the hills yield ſweet herbage for the cattle; the plains are covered with grain of different denominations; and the woods are ſtored with variety of game. The Caſhmireans, according to our author, ſeem a race diſtinct from all others in the eaſt: Their perſons are more elegant, and their complexions more delicate and more tinged with red.

On the decadence of the Mogul power in Hindoſtan, Caſhmire felt ſome of the ravages of war. It is now however in peace; and the inhabitants are deſirous of keeping it ſo. They are ſprightly and ingenious, and have ſeveral curious manufactures much valued in India. They are all Mahometans or idolaters. Caſhmire is the capital town.

CASIMIR, the name of ſeveral kings of Poland. See (*Hiſtory of*) Poland.

Casimir, *Matthias Sorbiewſki*, a Poliſh Jeſuit, born in 1597. He was a moſt excellent poet; and is, ſays M. Baillet, an exception to the general rule of Ariſtotle and the other ancients, which teaches us to expect nothing ingenious and delicate from northern climates. His odes, epodes, and epigrams, have been thought not inferior to thoſe of the fineſt wits of Greece and Rome. Dr Watts has tranſlated one or two of his ſmall pieces, which are added to his Lyric Poems. He died at Warſaw in 1640, aged 43. There have been many editions of his poems, the beſt of which is that of Paris, 1759.

CASING *of* timber work, among builders, is the plaſtering the houſe all over the outſide with mortar, and then ſtriking it while wet, by a ruler, with the corner of a trowel, to make it reſemble the joints of freeſtone. Some direct it to be done upon heart-laths, becauſe the mortar would, in a little time, decay the ſap laths; and to lay on the mortar in two thickneſſes, viz. a ſecond before the firſt is dry.

CASK, or Casque, a piece of defenſive armour wherewith to cover the head and neck; otherwiſe called the *head-piece* and *helmet* *. The word is French, *caſque*, from *caſſicum* or *caſſicus*, a diminutive of *caſſis* "a helmet." Le Gendre obſerves, that anciently, in France, the gens d'armes all wore *caſks*. The king wore a *caſk* gilt; the dukes and counts ſilvered; gentlemen of extraction poliſhed ſteel; and the reſt plain iron.

The caſk is frequently ſeen on ancient medals, where we may obſerve great varieties in the form and faſhion thereof; as the Greek faſhion, the Roman faſhion, &c. F. Joubert makes it the moſt ancient of all the coverings of the head, as well as the moſt univerſal. Kings, emperors, and even gods themſelves, are ſeen therewith. That which covers the head of Rome has uſually two wings like thoſe of Mercury; and that of ſome kings is furniſhed with horns like thoſe of Jupiter Ammon; and ſometimes barely bulls or rams horns, to expreſs uncommon force.

Cask, in *Heraldry*, the ſame with helmet. See Heraldry, No. 45.

Cask, a veſſel of capacity, for preſerving liquors of divers kinds; and ſometimes alſo dry goods, as ſugar, almonds, &c.—A caſk of ſugar is a barrel of that commodity, containing from eight to eleven hundred weight. A caſk of almonds is about three hundred weight.

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* *Philoſophical Rhapſodies.*

* See *Helmet.*

CASKET, in a general ſenſe, a little coffer or cabinet. See CABINET.

CASKETS, in the ſea language, are ſmall ropes made of ſinnet, and faſtened to gromets, or little rings upon the yards; their uſe is to make faſt the ſail to the yard when it is to be furled.

Biog. Brit. and Anecdotes of Bowyer, by Nichols.

CASLON, WILLIAM, eminent in an art of the greateſt conſequence to literature, the art of letter-founding, was born in 1692, in that part of the town of Hales Owen which is ſituated in Shropſhire. Though he juſtly attained the character of being the Coryphæus in that employment, he was not brought up to the buſineſs; and it is obſerved by Mr Mores, that this handywork is ſo concealed among the artificers of it, that he could not diſcover that any one had taught it to another, but every perſon who had uſed it had learned it of his own genuine inclination. Mr Caſlon ſerved a regular apprenticeſhip to an engraver of ornaments on gun barrels; and after the expiration of his term, carried on this trade in Vine-ſtreet, near the Minories. He did not, however, ſolely confine his ingenuity to that inſtrument, but employed himſelf likewiſe in making tools for the bookbinders, and for the chaſing of ſilver-plate. Whilſt he was engaged in this buſineſs, the elder Mr Bowyer accidentally ſaw, in a bookſeller's ſhop, the lettering of a book uncommonly neat; and inquiring who the artiſt was by whom the letters were made, was hence induced to ſeek an acquaintance with Mr Caſlon. Not long after, Mr Bowyer took Mr Caſlon to Mr James's foundery, in Bartholomew-cloſe. Caſlon had never before that time ſeen any part of the buſineſs; and being aſked by his friend, if he thought he could undertake to cut types, he requeſted a ſingle day to conſider the matter; and then replied that he had no doubt but he could. Upon this anſwer, Mr Bowyer, Mr Bettenham, and Mr Watts, had ſuch a confidence in his abilities, that they lent him 500l. to begin the undertaking, and he applied himſelf to it with equal aſſiduity and ſucceſs. In 1720, the ſociety for promoting Chriſtian knowledge, in conſequence of a repreſentation from Mr Solomon Negri, a native of Damaſcus in Syria, who was well ſkilled in the oriental tongues, and had been profeſſor of Arabic in places of note, deemed it expedient to print, for the uſe of the Eaſtern churches, the New Teſtament and Pſalter, in the Arabic language. Theſe were intended for the benefit of the poor Chriſtians in Paleſtine, Syria, Meſopotamia, Arabia, and Egypt, the conſtitution of which countries did not permit the exerciſe of the art of printing. Upon this occaſion Mr Caſlon was pitched upon to cut the fount; in his ſpecimens of which he diſtinguiſhed it by the name of Engliſh Arabic. Under the farther encouragement of Mr Bowyer, Mr Bettenham, and Mr Watts, he proceeded with vigour in his employment; and he arrived at length to ſuch perfection, that he not only freed us from the neceſſity of importing types from Holland, but in the beauty and elegance of thoſe made by him he ſo far exceeded the productions of the beſt artificers, that his workmanſhip was frequently exported to the continent. In ſhort, his foundery became, in proceſs of time, the moſt capital one that exiſts in this or in foreign countries. Having acquired opulence in the courſe of his employment, he was put into the commiſſion of the peace for the county of Middleſex. Towards the latter end of his life, his eldeſt ſon being in partnerſhip with him, he retired in a great meaſure from the active execution of buſineſs. His death happened in January 1766.

CASPIAN SEA, a large lake of ſalt water in Aſia, bounded by the province of Aſtrakan on the north, and by part of Perſia on the ſouth, eaſt, and weſt. It is upwards of 400 miles long from ſouth to north, and 300 broad from eaſt to weſt. This ſea forms ſeveral gulfs, and embraces between Aſtrakan and Aſtrabad an incredible number of ſmall iſlands. Its bottom is mud, but ſometimes mixed with ſhells. At the diſtance of ſome German miles from land it is 500 fathoms deep; but on approaching the ſhore it is everywhere ſo ſhallow, that the ſmalleſt veſſels, if loaded, are obliged to remain at a diſtance.

When we conſider that the Caſpian is encloſed on all ſides by land, and that its banks are in the neighbourhood of very high mountains, we eaſily ſee why the navigation in it ſhould be perfectly different from that in every other ſea. There are certain winds that domineer over it with ſuch abſolute ſway, that veſſels are often deprived of every reſource; and in the whole extent of it there is not a port that can truly be called ſafe. The north, north eaſt, and eaſt winds, blow moſt frequently, and occaſion the moſt violent tempeſts. Along the eaſtern ſhore the eaſt winds prevail; for which reaſon veſſels bound from Perſia to Aſtrakan always direct their courſe along this ſhore.

The ſurface of the Caſpian ſea is lower than the ocean. Although its extent is immenſe, the variety of its productions is exceedingly ſmall. This undoubtedly proceeds from its want of communication with the ocean, which cannot impart to it any portion of its inexhauſtible ſtores. But the animals which this lake nouriſhes multiply to ſuch a degree, that the Ruſſians, who alone are in condition to make them turn to account, juſtly conſider them as a never-failing ſource of profit and wealth. It will be underſtood that we ſpeak of the fiſh of the Caſpian, and of its fiſheries, which make the ſole occupation and principal trade of the people inhabiting the banks of the Wolga and of the Jaïk. This buſineſs is diſtinguiſhed into the great and leſſer fiſheries. The fiſh comprehended under the firſt diviſion, ſuch as the ſturgeon and others, abound in all parts of the Caſpian, as well as in the rivers that communicate with it, and which they aſcend at ſpawning time. The ſmall fiſhes, ſuch as the ſalmon and many others, obſerve the general law of quitting the ſalt waters for the freſh; nor is there an inſtance of one of them remaining conſtantly in the ſea.

Seals are the only quadrupeds that inhabit the Caſpian; but they are there in ſuch numbers as to afford the means of ſubſiſtence to many people in that country as well as in Greenland. The varieties of the ſpecies are numerous, diverſified however only by the colour. Some are quite black, others quite white; there are ſome whitiſh, ſome yellowiſh, ſome of a mouſe colour, and ſome ſtreaked like a tiger. They crawl by means of their fore feet upon the iſlands, where they become the prey of the fiſhermen, who kill

Caſpian ſea.

them with long clubs. As ſoon as one is deſpatched, he is ſucceeded by ſeveral who come to the aſſiſtance of their unhappy companion, but come only to ſhare his fate. They are exceedingly tenacious of life, and endure more than thirty hard blows before they die. They will even live for ſeveral days after having received many mortal wounds. They are moſt terrified by fire and ſmoke; and as ſoon as they perceive them, retreat with the utmoſt expedition to the ſea. Theſe animals grow ſo very fat, that they look rather like oil bags than animals. At Aſtrakan is made a ſort of gray ſoap with their fat mixed with pot-aſhes, which is much valued for its property of cleanſing and taking greaſe from woollen ſtuffs. The greateſt numbers of them are killed in ſpring and autumn. Many ſmall veſſels go from Aſtrakan merely to catch ſeals.

If the Caſpian has few quadrupeds, it has in proportion ſtill fewer of thoſe natural productions which are looked upon as proper only to the ſea. There have never been found in it any zoophytes, nor any animal of the order of moluſca. The ſame may almoſt be ſaid of ſhells; the only ones found being three or four ſpecies of cockle, the common muſcle, ſome ſpecies of ſnails, and one or two others.

But to compenſate this ſterility, it abounds in birds of different kinds. Of thoſe that frequent the ſhores, there are many ſpecies of the gooſe and duck kind, of the ſtork and heron, and many others of the water tribe. Of birds properly aquatic, it contains the grebe, the creſted diver, the pelican, the cormorant, and almoſt every ſpecies of gull. Crows are ſo fond of fiſh, that they haunt the ſhores of the Caſpian in prodigious multitudes.

The waters of this lake are very impure, the great number of rivers that run into it, and the nature of its bottom, affecting it greatly. It is true, that in general the waters are ſalt; but though the whole weſtern ſhore extends from the 46th to the 35th degree of north latitude; and though one might conclude from analogy that theſe waters would contain a great deal of ſalt, yet experiments prove the contrary: and it is certain that the ſaltneſs of this ſea is diminiſhed by the north, north-eaſt, and north-weſt winds; although we may with equal reaſon conclude, that it owes its ſaltneſs to the mines of ſalt which lie along its two banks, and which are either already known or will be known to poſterity. The depth of theſe waters alſo diminiſhes gradually as you approach the ſhores, and their ſaltneſs in the ſame way grows leſs in proportion to their proximity to the land, the north winds not unfrequently cauſing the rivers to diſcharge into it vaſt quantities of troubled water impregnated with clay. Theſe variations which the ſea is expoſed to are more or leſs conſiderable, according to the nature of the winds; they affect the colour of the river waters to a certain diſtance from the ſhore, till theſe mixing with thoſe of the ſea, which then reſume the aſcendancy, the fine green colour appears, which is natural to the ocean, and to all thoſe bodies of water that communicate with it.

It is well known, that beſides its ſalt taſte, all ſea water has a ſenſible bitterneſs, which muſt be attributed not only to the ſalt itſelf, but to the mixture of different ſubſtances that unite with it, particularly to different ſorts of alum, the ordinary effect of different combinations of acids. Beſides this, the waters of the Caſpian have another taſte, bitter too, but quite diſtinct, which affects the tongue with an impreſſion ſimilar to that made by the bile of animals; a property which is peculiar to this ſea, though not equally ſenſible at all ſeaſons. When the north and north-weſt winds have raged for a conſiderable time, this bitter taſte is ſenſibly felt; but when the wind has been ſouth, very imperfectly. We ſhall endeavour to account for this phenomenon.

Caſpian ſea.

The Caſpian is ſurrounded on its weſtern ſide by the mountains of Caucaſus, which extend from Derbent to the Black ſea. Theſe mountains make a curve near Aſtrakan, and directing their courſe towards the eaſtern ſhore of the Caſpian, loſe themſelves near the mouth of the Jaïk, where they become ſecondary mountains, being diſpoſed in ſtrata. As Caucaſus is an inexhauſtible magazine of combuſtible ſubſtances, it conſequently lodges an aſtoniſhing quantity of metals in its bowels. Accordingly, along the foot of this immenſe chain of mountains, we ſometimes meet with warm ſprings, ſometimes ſprings of naphtha of different quality; ſometimes we find native ſulphur, mines of vitriol, or lakes heated by internal fires. Now the foot of Mount Caucaſus forming the immediate weſtern ſhore of the Caſpian ſea, it is very eaſy to imagine that a great quantity of the conſtituent parts of the former muſt be communicated to the latter: but it is chiefly to the naphtha, which abounds ſo much in the countries which ſurround this ſea, that we muſt attribute the true cauſe of the bitterneſs peculiar to its waters; for it is certain that this bitumen flows from the mountains, ſometimes in all its purity, and ſometimes mixed with other ſubſtances which it acquires in its paſſage through ſubterranean channels, from the moſt interior parts of theſe mountains to the ſea, where it falls to the bottom by its ſpecific gravity. It is certain too, that the north and north-weſt winds detach the greateſt quantities of this naphtha; whence it is evident that the bitter taſte muſt be moſt ſenſible when theſe winds prevail. We may alſo comprehend why this taſte is not ſo ſtrong at the ſurface or in the neighbourhood of the ſhore, the waters there being leſs impregnated with ſalt, and the naphtha, which is united with the water by the ſalt, being then either carried to a diſtance by the winds, or precipitated to the bottom.

But it is not a bitter taſte alone that the naphtha communicates to the waters of the Caſpian: theſe waters were analyſed by M. Gmelin, and found to contain, beſides the common ſea ſalt, a conſiderable proportion of Glauber ſalt, intimately united with the former, and which is evidently a production of the naphtha.

As the waters of the Caſpian have no outlet, they are diſcharged by ſubterranean canals through the earth, where they depoſite beds of ſalt; the ſurface of which correſponds with that of the level of the ſea. The two great deſerts which extend from it to the eaſt and weſt are chiefly compoſed of a ſaline earth, in which the ſalt is formed by effloreſcence into regular cryſtals; for which reaſon ſalt ſhowers and dews are exceedingly common in that neighbourhood. The ſalt of the marſhes at Aſtrakan, and that found in effloreſcence in the deſerts, is by no means pure ſea ſalt;

but much debaſed by the bitter Glauber ſalt we mentioned above. In many places indeed it is found with cryſtals of a lozenge ſhape, which is peculiar to it, without any cubical appearance, the form peculiar to cryſtals of ſea ſalt.

A great deal has been written on the ſucceſſive augmentation and decreaſe of the Caſpian ſea, but with little truth. There is indeed to be perceived in it a certain riſe and fall of its waters; in which, however, no obſervation has ever diſcovered any regularity.

Many ſuppoſe (and there are ſtrong preſumptions in favour of the ſuppoſition), that the ſhores of the Caſpian were much more extenſive in ancient times than they are at preſent, and that it once communicated with the Black ſea. It is probable too, that the level of this laſt ſea was once much higher than it is at preſent. If then it be allowed, that the waters of the Black ſea, before it procured an exit by the ſtraits of Conſtantinople, roſe ſeveral fathoms above their preſent level, which from many concurring circumſtances may eaſily be admitted, it will follow, that all the plains of the Crimea, of the Kuman, of the Wolga, and of the Jaïk, and thoſe of Great Tartary beyond the lake of Aral, in ancient times formed but one ſea, which embraced the northern extremity of Caucaſus by a narrow ſtrait of little depth; the veſtiges of which are ſtill obvious in the river Mantyſch.

CASQUE, or Cask. See Cask.

CASSADA. See Jatropha, Botany *Index*.

CASSANA, Nicolo, called Nicoletto, an eminent Italian painter, was born at Venice in 1659, and became a diſciple of his father Giovanni Franceſco Caſſana, a Genoeſe, who had been taught the art of painting by Bernardino Strozzi. He ſoon diſtinguiſhed himſelf, not only by the beauty of his colouring, but by the gracefulneſs of his figures in hiſtorical compoſitions, as well as in portrait. The moſt eminent perſonages ſolicited him to enrich their cabinets with ſome of his performances; and were more particularly deſirous to obtain their portraits, becauſe in that branch he excelled beyond competition. The grand duke of Tuſcany, who was an excellent judge of merit in all profeſſions, and as liberal an encourager of it, invited Nicoletto to his court; and he there painted the portraits of that prince and the princeſs Violante his conſort. Theſe performances procured him uncommon applauſe, as well as a noble gratuity, and he was employed and careſſed by the principal nobility of Florence. Beſide ſeveral hiſtorical ſubjects painted by this maſter while he reſided in that city, one was a very capital deſign: The ſubject of it was the *Conſpiracy of Catiline*; it conſiſted of nine figures as large as life, down to the knees; and the two principal figures were repreſented as with one hand joined in the preſence of their companions, and in their other hand holding a cup of blood. Some of the Engliſh nobility on their travels ſat to him for their portraits; which being ſent to London, and highly admired, Nicoletto was invited to England, with ſtrong aſſurances of a generous reception; and on his arrival he experienced the kindneſs, the reſpect, and the liberality, ſo peculiar to the natives of that kingdom. He had the honour of being introduced to the preſence of Queen Anne, and to paint her portrait; in which he ſucceeded ſo happily, that the queen diſtinguiſhed him by many marks of favour and honour; but he had not the happineſs to enjoy his good fortune for any length of time, dying in London, univerſally regretted, in the year 1713.

Cassana, *Giovanni Agoſtino*, called *L'Abate Caſſana*, was brother to the preceding, and born in 1664. He was educated along with him by their father Franceſco Caſſana, and he finiſhed his ſtudies at Venice, where his brother Nicolo reſided for ſome time. Although he compoſed and deſigned hiſtorical ſubjects with expertneſs, and with a correctneſs of outline equal to his brother; yet, from prudence and fraternal affection, he declined to interfere with him, and choſe therefore to deſign and paint all ſorts of animals and fruits. In that ſtyle he arrived at a high degree of excellence, imitating nature with exactneſs, beauty, and truth: expreſſing the various plumage of his birds, and the hairs of the different animals, with ſuch tenderneſs and delicacy as rendered them eſtimable to all judges and lovers of the art. His works were admitted into the collections of thoſe of the firſt rank, and accounted ornaments of thoſe repoſitories of what is curious or valuable. He alſo painted fruits of thoſe kinds which were the moſt uncommon, or naturally of odd and ſingular colours; and ſuch fiſhes as ſeemed worthy to excite admiration by their unuſual form, colour, or appearance. But beſides thoſe ſubjects, he ſometimes painted the portraits of particular perſons of diſtinction, which he deſigned, coloured and touched, with the ſame degree of merit that was viſible in all his other performances. At laſt he determined to viſit Genoa, where his family had lived in eſteem; and took with him ſeveral pictures which he had already finiſhed. His intention was to diſplay his generoſity, and to appear as a perſon of more wealth, and of greater conſequence, than he really was; and to ſupport that character, he beſtowed his pictures on ſeveral of the principal nobility of that city. But, unhappily, he experienced no grateful return for all that prodigal munificence: he reduced himſelf by that vain liberality to the moſt neceſſitous circumſtances; was deprived of the means to procure for himſelf even the common neceſſaries of life; and waſted away the remainder of his days in the bitterneſs of poverty, miſery, and neglect.

CASSANDER, king of Macedon after Alexander the Great, was the ſon of Antipater. He made ſeveral conqueſts in Greece, aboliſhed democracy at Athens, and gave the government of that ſtate to the orator Demetrius. Olympias, the mother of Alexander, having cauſed Aridæus and his wife Eurydice, with others of Caſſander's party, to be put to death, he beſieged Pydne, whither the queen had retired, took it by a ſtratagem, and cauſed her to be put to death. He married Theſſalonica, the ſiſter of Alexander the Great; and killed Roxana and Alexander, the wife and ſon of that conqueror. At length he entered into an alliance with Seleucus and Lyſimachus, againſt Antigonus and Demetrius; over whom he obtained a great victory near Ipſus in Phrygia, 301 years before the Chriſtian era, and died three years after, in the 19th year of his reign.

CASSANDRA, in fabulous hiſtory, the daughter of Priam and Hecuba, was beloved of Apollo, who promiſed to beſtow on her the ſpirit of prophecy, provided ſhe would conſent to his love. Caſſandra ſeemed to accept the propoſal; but had no ſooner obtained that gift, than ſhe laughed at the tempter, and broke her word. Apollo, being enraged, revenged himſelf, by cauſing no credit to be given to her predictions, hence ſhe in vain propheſied the ruin of Troy. Ajax, the ſon of Oileus, having raviſhed her in the temple of Minerva, he was ſtruck with thunder. She fell into the hands of Agamemnon, who loved her to diſtraction; but in vain did ſhe predict that he would be aſſaſſinated in his own country. He was killed, with her, by the intrigues of Clytemneſtra; but their death was avenged by Oreſtes.

CASSANO, a town of Italy in the duchy of Milan, rendered remarkable by an obſtinate battle fought there between the Germans and French in 1705. It is ſubject to the houſe of Auſtria, and is ſeated on the river Adda, in E. Long. 10. 0. N. Lat. 45. 20.

Cassano, a town of Italy in Calabria citerior, in the kingdom of Naples, with a biſhop's ſee. E. Long. 16. 30. N. Lat. 39. 55.

CASSAVI, or Cassada. See Jatropha, Botany *Index*.

CASSEL, a town of French Flanders, and capital of a chatellany of the ſame name: It is ſeated on a mountain, where the terrace of the caſtle is ſtill to be ſeen; and from whence there is one of the fineſt proſpects in the world; for one may ſee no leſs than 32 towns, with a great extent of the ſea, from whence it is diſtant 15 miles. E. Long. 2. 27. N. Lat. 50. 48.

Cassel, the capital city of the landgravate of Heſſe-Caſſel, in the circle of the Upper Rhine in Germany; (ſee Hesse Cassel). It is divided into the Old, New, and High Towns. The New Town is beſt built, the houſes being of ſtone, and the ſtreets broad. The houſes of the Old Town, which is within the walls, are moſtly of timber; but the ſtreets are broad, and the market places ſpacious. The place is ſtrongly fortified, but the fortifications are not regular. It contains about 32,000 inhabitants, of whom a great proportion are French Proteſtants. Theſe have eſtabliſhed ſeveral manufactories in the place, particularly in the woollen branch. It is ſeated on the declivity of a hill near the river Fulva, in E. Long. 9. 28. N. Lat. 51. 20.

CASSIA. See Botany *Index*.

Cassia *Lignea*. See Laurus.

CASSIDA. See Scutellaria, Botany *Index*.

Cassida, in *Zoology*, a genus of inſects belonging to the order of coleoptera. See Entomology *Index*.

CASSIMER, or Casimer, the name of a thin tweeled woollen cloth, much in faſhion for ſummer uſe.

CASSIMIRE, or Cashmire. See Cashmire.

CASSINE. See Botany *Index*. The Spaniards who live near the gold mines of Peru, are frequently obliged to drink an infuſion of this herb in order to moiſten their breaſts; without which they are liable to a ſort of ſuffocation, from the ſtrong metallic exhalations that are continually proceeding from the mines. In Paraguay, the Jeſuits make a great revenue by importing the leaves of this plant into many countries, under the name of Paraguay or South ſea tea, which is there drank in the ſame manner as that of China or Japan is with us. It is with difficulty preſerved in England.

CASSINI, Johannes Dominicus, a moſt excellent aſtronomer, was born at Piedmont in 1635. His early proficiency in aſtronomy procured him an invitation to be mathematical profeſſor at Bologna when he was no more than 15 years of age: and a comet appearing in 1652, he diſcovered that comets were not accidental meteors, but of the ſame nature, and probably governed by the ſame laws, as the planets. In the ſame year he ſolved a problem given up by Kepler and Bullialdus as inſolvable, which was, to determine geometrically the apogee and eccentricity of a planet from its true and mean place. In 1663, he was appointed inſpector general of the fortifications of the caſtle of Urbino, and had afterwards the care of all the rivers in the eccleſiaſtical ſtate: he ſtill however proſecuted his aſtronomical ſtudies, by diſcovering the revolution of Mars round his own axis; and, in 1666, publiſhed his theory of Jupiter's ſatellites. Caſſini was invited into France by Louis XIV. in 1669, where he ſettled as the firſt profeſſor in the royal obſervatory. In 1677 he demonſtrated the line of Jupiter's diurnal rotation; and in 1684 diſcovered four more ſatellites belonging to Saturn, Huygens having found one before. He inhabited the royal obſervatory at Paris more than forty years; and when he died in 1712, was ſucceeded by his only ſon James Caſſini.

Cassini, *James*, another celebrated aſtronomer, was the younger ſon of the former. He was born at Paris, 18th February 1677. It would appear that his early ſtudies were conducted in his father's houſe, where, from the purſuits and ſtudies of his father, mathematics, and their application to aſtronomy, it is probable, were not neglected. He became a ſtudent afterwards at the Mazarine college, at the time that the celebrated Varignon was profeſſor of mathematics. With the aſſiſtance of this eminent man young Caſſini made ſuch progreſs, that at 15 years of age he ſupported a mathematical theſis with great honour. At the age of 17 he was admitted a member of the Academy of Sciences; and the ſame year he accompanied his father in a journey to Italy, where he aſſiſted him in the verification of the meridian at Bologna and other meaſurements. After his return he performed ſimilar operations in a journey into Holland, and he diſcovered ſome errors in the meaſure of the earth by Snell, the reſult of which was communicated to the Academy in 1702. In 1696 he made alſo a viſit to England, where he was made a member of the Royal Society. In 1712 he ſucceeded his father as aſtronomer royal at the obſervatory of Paris. In 1717 he gave to the Academy his reſearches on the diſtance of the fixed ſtars; in which he ſhewed that the whole annual orbit, of near 200 millions of miles diameter, is but as a point in compariſon of that diſtance. The ſame year he communicated alſo his diſcoveries concerning the inclination of the orbits of the ſatellites in general, and eſpecially of thoſe of Saturn's ſatellites and ring. In 1725 he undertook to determine the cauſe of the moon's libration, by which ſhe ſhews ſometimes a little towards one ſide, and ſometimes a little on the other, of that half which is commonly behind or hid from our view.

In 1732 an important queſtion in aſtronomy enga-

Caſſini.

ged the ingenuity of our author. His father had determined, by his obſervations, that the planet Venus revolved about her axis in the ſpace of 23 hours; and M. Bianchini had publiſhed a work in 1729, in which he ſettled the period of the ſame revolution at 24 days 8 hours. From an examination of Bianchini's obſervations which were upon the ſpots in Venus, he diſcovered that he had intermitted his obſervations for the ſpace of three hours, from which cauſe he had probably miſtaken new ſpots for the old ones, and ſo had been led into the miſtake. He alſo determined the nature and quantity of the acceleration of the motion of Jupiter at half a ſecond per year, and of that of the retardation of Saturn at two minutes per year; that theſe quantities would go on increaſing for 2000 years, and then would decreaſe again. In 1740 he publiſhed his Aſtronomical Tables, and his elements of Aſtronomy; very extenſive and accurate works.

Aſtronomy was the principal object of our author's conſideration, but he did not confine himſelf abſolutely to that purſuit, but made occaſional excurſions into other fields. We owe to him experiments on Electricity, Experiments on the Recoil of Fire-arms; Reſearches on the Riſe of the Mercury in the Barometer at different Heights; Reflections on the perfecting of Burning-glaſſes; and ſome other memoirs.

One of the moſt important objects of the French academy was the meaſurement of the earth. In 1669 Picard meaſured a little more than a degree of latitude to the north of Paris; but as that extent appeared too ſmall from which to conclude the whole circumference with ſufficient accuracy, it was reſolved to continue that meaſurement on the meridian of Paris to the north and the ſouth, through the whole extent of the country. Accordingly, in 1683, the late M. de la Hire continued that on the north ſide of Paris, and the older Caſſini that on the ſouth ſide. The latter was aſſiſted in 1700 in the continuation of this operation by his ſon our author. The ſame work was farther continued by the ſame academicians; and finally, the part left unfiniſhed by De la Hire in the north was finiſhed in 1718 by our author, with the late Maraldi, and De la Hire the younger.

Theſe operations produced a conſiderable degree of preciſion. From this meaſured extent of ſix degrees, it appeared alſo, that the degrees were of different lengths in different parts of the meridian; and our author concluded, in the volume publiſhed for 1718, that they decreaſed more and more towards the pole, and that therefore the figure of the earth was that of an oblong ſpheroid, or having its axis longer than the equatorial diameter. He alſo meaſured the perpendicular to the ſame meridian, and compared the meaſured diſtance with the differences of longitude as before determined by the eclipſes of Jupiter's ſatellites: from which he concluded that the length of the degrees of longitude was ſmaller than it would be on a ſphere, and that therefore again the figure of the earth was an oblong ſpheroid, contrary to the determination of Newton by the theory of gravity. Newton was indeed of all men the moſt averſe from controverſy; but the other mathematicians in Britain did not tamely ſubmit to concluſions in direct oppoſition to the fundamental doctrine of this philoſopher. The conſequence was, that the French government ſent two different ſets of meaſurers, the one to meaſure a degree at the equator, the other at the polar circle; and the compariſon of the whole determined the figure to be an oblate ſpheroid, contrary to Caſſini's determination.

After a long and laborious life, James Caſſini died in April 1756, and was ſucceeded in the Academy and Obſervatory by his ſecond ſon. He publiſhed, A Treatiſe on the Magnitude and Figure of the Earth; as alſo, The Elements or Theory of the Planets, with Tables; beſide a great number of papers in the Memoirs of the Academy, from the year 1699 to 1755.

Caſſini de Thury.

Cassini *de Thury*, *Ceſar Francois*, a celebrated French aſtronomer, director of the obſervatory, and member of moſt of the learned ſocieties of Europe, was born at Paris June 17, 1714. He was the ſecond ſon of James Caſſini, whoſe occupations and talents he inherited and ſupported with great honour. He received his firſt leſſons in aſtronomy and mathematics from MM. Maraldi and Camus; and made ſuch a rapid progreſs, that when he was not more than ten years of age he calculated the phaſes of a total eclipſe of the ſun. At the age of eighteen he accompanied his father in his two journeys undertaken for drawing the perpendicular to the obſervatory meridian from Straſbourg to Breſt. A general chart of France was from that time deviſed; for which purpoſe it was neceſſary to traverſe the country by ſeveral lines parallel and perpendicular to the meridian of Paris. Our author was charged with the conduct of this buſineſs; in which he was ſo ſcrupulous as to meaſure again what had been meaſured by his father. This great work was publiſhed in 1740, with a chart ſhewing the new meridian of Paris, by two different ſeries of triangles, paſſing along the ſea coaſts to Bayonne, traverſing the frontiers of Spain to the Mediterranean and Antibes, and thence along the eaſtern limits of France to Dunkirk, with parallel and perpendicular lines deſcribed at the diſtance of 6000 toiſes from one another, from ſide to ſide of the country.

Our author made a tour in 1741, in Flanders, in the train of the king. This gave riſe, at his Majeſty's inſtance, to the chart of France; relative to which Caſſini publiſhed different works, as well as a great number of the ſheets of the chart itſelf. He undertook, in 1761, an expedition into Germany, for the purpoſe of continuing to Vienna the perpendicular of the Paris meridian; to unite the triangles of the chart of France with the points taken in Germany; to prepare the means of extending into that country the ſame plan as in France; and thus to eſtabliſh ſucceſſively for all Europe a moſt uſeful uniformity. Our author was at Vienna the 6th of June 1761, the day of the tranſit of the planet Venus over the ſun, of which he obſerved as much as the ſtate of the weather would permit him to do, and publiſhed the account of it in his *Voyage en Allemagne*.

Caſſini, always meditating the perfection of his grand deſign, profited of the peace of 1783 to propoſe the joining of certain points taken upon the Engliſh coaſt with thoſe which had been determined on the coaſt of France, and thus to connect the general chart of the latter with that of the Britiſh iſles, as he had before united it with thoſe of Flanders and Germany. The propoſal was favourably received by the Engliſh government, and preſently carried into effect under the direction of the Royal Society, by the late General Roy.

Between the years 1735 and 1770, M. Caſſini publiſhed, in the volumes of Memoirs of the French Academy, a great number of pieces, conſiſting chiefly of aſtronomical obſervations and queſtions; among which are reſearches concerning the parallax of the ſun, the moon, Mars and Venus; on aſtronomical refractions, and the effect cauſed in their quantity and laws by the weather; numerous obſervations on the obliquity of the ecliptic, and on the law of its variations. He cultivated aſtronomy for 50 years, the moſt important for that ſcience that ever elapſed for the magnitude and variety of objects; and in which he commonly ſuſtained a principal ſhare.

M. Caſſini was of a very ſtrong and vigorous conſtitution, which carried him through the many laborious operations in geography and aſtronomy which he conducted. An habitual retention of urine, however, rendered the laſt twelve years of his life very painful and diſtreſſing, till it was at length terminated by the ſmall-pox the 4th of September 1784, in the 71ſt year of his age. He was ſucceeded in the academy, and as director of the obſervatory, by his only ſon John-Dominic Caſſini, the fourth in order of direct deſcent who has filled that honourable ſtation. *Hutton's Math. Dict.*

CASSIODORUS, Marcus Aurelius, ſecretary of ſtate to Theodoric king of the Goths, was born at Squillace, in the kingdom of Naples, about the year 470. He was conſul in 514, and was in great credit under the reigns of Athalaric and Vitiges; but at 70 years of age retired into a monaſtery in Calabria, where he amuſed himſelf in making ſun dials, water-hour glaſſes, and perpetual lamps. He alſo formed a library; and compoſed ſeveral works, the beſt edition of which is that of Father Garet, printed at Rouen in 1679. Thoſe moſt eſteemed are his Divine Inſtitutions, and his Treatiſe on the Soul. He died about the year 562.

CASSIOPEIA, in fabulous hiſtory, wife to Cepheus king of Ethiopia, and mother of Andromeda. She thought herſelf more beautiful than the Nereides, who deſired Neptune to revenge the affront; ſo that he ſent a ſea monſter into the country, which did much harm. To appeaſe the god, her daughter Andromeda was expoſed to the monſter, but was reſcued by Perſeus; who obtained of Jupiter, that Caſſiopeia might be placed after her death among the ſtars: hence the conſtellation of that name.

Cassiopeia, in *Aſtronomy*, one of the conſtellations of the northern hemiſphere, ſituated next to Cepheus. In 1572, there appeared a new ſtar in this conſtellation, which at firſt ſurpaſſed in magnitude and brightneſs Jupiter himſelf: but it diminiſhed by degrees, and at laſt diſappeared, at the end of eighteen months. It alarmed all the aſtronomers of that age, many of whom wrote diſſertations on it; among the reſt Tycho Brahe, Kepler, Maurolycus, Lycetus, Gramineus, &c. Beza, the landgrave of Heſſe, Roſa, &c. wrote to prove it a comet, and the ſame which appeared to the Magi at the birth of Jeſus Chriſt, and that it came to declare his ſecond coming; they were anſwered on this ſubject by Tycho. The ſtars in the conſtellation Caſſiopeia, in Ptolemy's catalogue, are 13; in Hevelius's, 33: in Tycho's, 46; But in the Britannic catalogue Mr Flamſtead makes them 55.

CASSIS, in antiquity, a plated or metalline helmet; different from the *galea*, which was of leather.

CASSITERIA, in the hiſtory of foſſils, a genus of cryſtals, the figures of which are influenced by an admixture of ſome particles of tin.

The caſſiteria are of two kinds; the whitiſh pellucid caſſiterion, and the brown caſſiterion. The firſt is a tolerably bright and pellucid cryſtal, and ſeldom ſubject to the common blemiſhes of cryſtal: it is of a perfect and regular form, in the figure of a quadrilateral pyramid: and is found in Devonſhire and Cornwall principally. The brown caſſiterion is like the former in figure: it is of a very ſmooth and gloſſy ſurface, and is alſo found in great plenty in Devonſhire and Cornwall.

CASSITERIDES, in *Ancient Geography*, a cluſter of iſlands to the weſt of the Land's End; oppoſite to Celtiberia, (Pliny); famous for their tin, which he calls *candidum plumbum*, formerly open to none but the Phœnicians, who alone carried on this commerce from Gades, concealing the navigation from the reſt of the world, (Strabo). The appellation is from *Caſſiteros*, the name for tin in Greek. Now thought to be the Scilly iſlands, or Sorlings, (Camden).

CASSIUS, Spurius, a renowned Roman general and conſul, whoſe enemies accuſing him of aſpiring to royalty, he was thrown down from the Tarpeian rock 485 years before Chriſt; after having thrice enjoyed the conſular dignity, been once general of the horſe under the firſt dictator that was created at Rome, and twice received the honour of a triumph.

Cassius, *Longinus*, a celebrated Roman lawyer, flouriſhed 113 years before Chriſt. He was ſo inflexible a judge, that his tribunal was called the *Rock of the impeached*. It is from the judicial ſeverity of this Caſſius, that very ſevere judges have been called *Caſſiani*.

Cassius, *Caius*, one of the murderers of Julius Cæſar: after his defeat by Mark Antony at the battle of Philippi, he ordered one of his freed men to put him to death with his own ſword, 41 years before Chriſt. See Rome.

CASSOCK, or Cassula, a kind of robe or gown, worn over the reſt of the habit, particularly by the clergy. The word caſſock comes from the French *caſſaque*, a horſeman's coat.

CASSONADE, in commerce, caſk-ſugar, or ſugar put into caſks or cheſts, after the firſt purification, but which has not been refined. It is ſold either in powder or in lumps; the whiteſt, and that of which the lumps are largeſt, is the beſt. Many imagine it to ſweeten more than loaf ſugar; but it is certain that it yields a great deal more ſcum.

CASSOWARY. See Struthio, Ornithology *Index*.

CASSUMAR, in the *Materia Medica*, a root reſembling that of zedoary.

It is cardiac and ſudorific, and famous in nervous caſes; it is alſo an ingredient in many compoſitions, and is preſcribed in powders, boluſes, and infuſions. Its doſe is from five to fifteen grains.

Caſſumbazar || Caſtagno

CASSUMBAZAR, a town of India in Aſia, ſituated on the river Ganges, in the province of Bengal. E. Long. 37. and N. Lat. 24.

CAST is peculiarly uſed to denote a figure or ſmall ſtatue [illegible]

Cast, among founders, denotes the tubes of wax fitted in divers parts of a mould of the ſame matter; by means of which, when the wax of the mould is removed, the melted metal is conveyed into all the parts which the wax before poſſeſſed.

Cast, alſo denotes a cylindrical piece of braſs or copper, ſlit in two, lengthwiſe, uſed by the founders in ſand, to form a canal or conduit in their moulds, whereby the metal may be conveyed to the different pieces intended to be caſt.

Cast, among plumbers, denotes a little brazen funnel at one end of a mould, for caſting pipes without ſoldering, by means of which the melted metal is poured into the mould.

Cast, or *Caſte*, in ſpeaking of the eaſtern affairs, denotes a tribe, or number of families, of the ſame rank and profeſſion. The diviſion of a nation into caſts chiefly obtains in the dominions of the Great Mogul, kingdom of Bengal, iſland of Ceylon, and the great peninſula oppoſite thereto. In each of theſe there are, according to Father Martin, four principal caſts, viz. the caſt of the *bramins*, which is the firſt and moſt noble; the caſt of the *rajas*, or princes, who pretend to be deſcended from divers royal families; the caſt of the *choutres*, which comprehends all the artificers; and that of the *parias*, the loweſt and moſt contemptible of all: though Henry Lord, it muſt be obſerved, divides the Indians about Surat into four *caſts*, ſomewhat differently from Martin, viz. into *bramins*, or prieſts; *cuttery*, or ſoldiers; *ſhuddery*, which we call *banians*, or merchants; and *wyſe*, the mechanics or artificers. Every art and trade is confined to its proper *caſt*, nor is allowed to be exerciſed by any but thoſe whoſe fathers profeſſed the ſame. So that a tailor's ſon can never riſe to be a painter, nor a painter's ſon fall to be a tailor; though there are ſome employments that are proper to all the caſts, e. g. every body may be a ſoldier or a merchant. There are alſo divers caſts which are allowed to till the ground, but not all. The caſt of *parias* is held infamous, inſomuch that it is a diſgrace to have any dealings or converſation with them; and there are ſome trades in the caſt of *choutres*, which debaſe their profeſſors almoſt to the ſame rank. Thus ſhoemakers, and all artificers in leather, as alſo fiſhermen, and even ſhepherds, are reputed no better than *parias*.

CASTAGNO, Andrea Dal, hiſtorical painter, was born at a ſmall village called *Caſtagno*, belonging to the territory of Tuſcany, in 1409: and being deprived of his parents, was employed by his uncle to attend the herds of cattle in the fields; but, having accidentally ſeen an ordinary painter at work in the country, he obſerved him for ſome time with ſurpriſe and attention, and afterwards made ſuch efforts to imitate him, as aſtoniſhed all who ſaw his productions. The extraordinary genius of Andrea became at laſt a common topic of diſcourſe in Florence; and ſo far excited the curioſity of Bernardetto de Medici, that he ſent for Andrea: and perceiving that he had promiſing talents, he placed him under the care of the beſt maſters who were at that time in Florence. Andrea diligently purſued his ſtudies, devoted himſelf entirely to practice under the direction of his inſtructors, became particularly eminent in deſign, and in a few years made ſo great a progreſs, that he found as much employment as he could poſſibly execute. He painted only in diſtemper, and freſco, with a manner of colouring that was not very agreeable, being rather dry and hard, till he learned the ſecret of painting in oil from Domenico Venetiano, who had derived his knowledge of that new diſcovery from Antonello da Meſſina. Andrea was the firſt of the Florentine artiſts who painted in oil; but although he was in the higheſt degree indebted to Domenico for diſcloſing the ſecret, yet he ſecretly envied the merit of the man who taught him the art; and becauſe his own works ſeemed to be much leſs admired than thoſe of Domenico, he determined to aſſaſſinate his friend and benefactor. He executed his deſign with the utmoſt ingratitude and treachery (for Domenico at that time lived with him, and painted in partnerſhip with him), and he ſtabbed him at a corner of a ſtreet ſo ſecretly, that he eſcaped, unobſerved and unſuſpected, to his own houſe, where he compoſedly ſat down to work; and thither Domenico was ſoon after conveyed, to die in the arms of his murderer. The real author of ſo inhuman a tranſaction was never diſcovered, till Andrea, through remorſe of conſcience, diſcloſed it on his death-bed, in 1480. He finiſhed ſeveral conſiderable works at Florence, by which he gained great riches, and as great a reputation; but when his villainous miſconduct became public, his memory was ever after held in the utmoſt deteſtation. The moſt noted work of this maſter is in the hall of juſtice at Florence, repreſenting the execution of the conſpirators againſt the houſe of Medicis.

Caſtagno || Caſtalio.

CASTALIAN spring. See Castalius.

CASTALIO, Sebastian, was born at Chatillon, on the Rhone, in the year 1515. Calvin conceived ſuch an eſteem and friendſhip for him, during the ſtay he made at Straſburg in 1540 and 1541, that he lodged him ſome days at his houſe, and procured him a regent's place in the college of Geneva. Caſtalio, after continuing in this office near three years, was forced to quit it in the year 1544, on account of ſome particular opinions which he held concerning Solomon's Song, and Chriſt's deſcent into hell. He retired to Baſil, where he was made Greek profeſſor, and died in that place in 1564, aged 48. He incurred the high diſpleaſure of Calvin and Theodore Beza, for differing with them concerning predeſtination and the puniſhment of heretics. His works are very conſiderable both on account of their quality and number. In 1545, he printed at Baſil four books of dialogues, containing the principal hiſtories of the Bible in elegant Latin; ſo that youth might thereby make a proficiency in piety and in the Latin tongue at the ſame time. But his principal work is a Latin and French tranſlation of the Scripture. He began the Latin tranſlation at Geneva in 1542, and finiſhed it at Baſil in 1550. It was printed at Baſil in 1551, and dedicated by the author to Edward VI. king of England. The French verſion was dedicated to Henry II. of

France, and printed at Baſil in 1555. The fault which has been moſt generally condemned in his Latin tranſlation, is the affectation of uſing only claſſical terms.

CASTALIUS FONS (Strabo, Pauſanias); *Caſtalia*, (Pindar, Virgil); A fountain at the foot of Mount Parnaſſus, in Phocis, near the temple of Apollo, or near Delphi; ſacred to the Muſes, thence called *Caſtalides*. Its murmurs were thought prophetic, (Nonnius, Lucian.) See the articles DELPHI and PARNASSUS.

CASTANEA. See FAGUS, BOTANY *Index*.

CASTANETS, CASTAGNETTES, or CASTANETTAS, a kind of muſical inſtrument, wherewith the Moors, Spaniards, and Bohemians, accompany their dances, ſarabands, and guitars. It conſiſts of two little round pieces of wood dried, and hollowed in manner of a ſpoon, the concavities whereof are placed on one another, faſtened to the thumb, and beat from time to time with the middle finger, to direct their motion and cadences. The *caſtanets* may be beat eight or nine times in the ſpace of one meaſure, or ſecond of a minute.

CASTANOVITZ, a town of Croatia, ſituated on the river Unna, which divides Chriſtendom from Turkey. E. Long. 17. 20. N. Lat. 45. 40. It is ſubject to the houſe of Auſtria.

CASTEL, LEWIS BERTRAND, a learned Jeſuit, was born at Montpelier in 1688, and entered among the Jeſuits in 1703. He ſtudied polite literature in his youth; and at length applied himſelf entirely to the ſtudy of mathematics and natural philoſophy. He diſtinguiſhed himſelf by writing on gravity; the mathematics; and on the muſic of colours, a very whimſical idea, which he took great pains to reduce to practice. His piece on gravity, entitled *Traité de la Penſateur univerſelle*, was printed at Paris in 1724. He afterwards publiſhed his *Mathematique univerſelle*; which occaſioned his being unanimouſly choſen a fellow of the Royal Society of London, without the leaſt ſolicitation. He was alſo a member of the academies of Bourdeaux and Rouen: but his *Clavecin oculaire* made the moſt noiſe; and he ſpent much time and expence in making an harpſichord for the eye, but without ſucceſs. He alſo wrote for and againſt Sir Iſaac Newton; and publiſhed ſeveral other works; the principal of which are, *Le Plan du Mathematique abregée*, and a treatiſe entitled *Optique des Couleurs*. He led a very exemplary life, and died in 1757.

CASTELAMARA, a town of Italy, in the kingdom of Naples, and the Hither Principato, with a biſhop's ſee, and a good harbour. E. Long. 14. 15. N. Lat. 41. 40.

CASTEL-ARAGONESE, a ſtrong town of Italy, in the iſland of Sardinia, with a biſhop's ſee, and a good harbour. It is ſeated on the N. W. coaſt of the iſland, in E. Long. 8. 57. N. Lat. 40. 56.

CASTEL-*Branco*, a town of Portugal, and capital of the province of Beira; ſeated on the river Lyra, 35 miles N. W. of Alcantara. W. Long. 8. 0. N. Lat. 39. 35.

CASTEL-*Franco*, a very ſmall, but well fortified frontier town of the Bologneſe, in Italy, belonging to the Pope.

CASTEL-*de-Vide*, a ſmall ſtrong town of Alentejo. It was taken by Philip V. W. Long. 6. 25. N. Lat. 39. 15.

CASTEL-*Folit*, a town of Spain, in Catalonia, ſeated on an inacceſſible eminence, between Gironne and Campredon, about 15 miles from each, and near the river Fulva.

CASTEL-*Gandolpho*, a town of Italy, in the territory of the church, with a caſtle, to which the pope retires in the ſummer ſeaſon; 10 miles S. by E. of Rome. E. Long. 12. 46. N. Lat. 41. 44.

CASTEL-*Novo*, a ſtrong town of Dalmatia, ſubject to the Venetians; ſeated on the gulf of Cataio, in E. Long. 18. 45. N. Lat. 42. 25.

CASTEL-*Rodrigo*, a town of Portugal, in the province of Tra-los-Montes, in W. Long. 7. 1. N. Lat. 41. 0.

CASTEL-*Novo-de-Carfagnana*, a town of Italy, in the Modeneſe, with a ſtrong fortreſs. It is the capital of the valley of Carfagnana, and ſeated on the river Serchio, 17 miles above Lucca.

CASTEL-*del-Ovo*, a ſmall iſland in the Tuſcan ſea, in the gulf of Naples, near a town of that name, to which it is joined by a ſtone bridge. The fortreſs is called Caſtel del Ovo, in which there is always a good garriſon.

CASTELBAR, a town of Ireland, in the county of Mayo, and province of Connaught, 35 miles N. of Galway. W. Long. 9. 25. N. Lat. 53. 45.

CASTELL, EDMUND, D. D. a learned Engliſh divine of the 17th century, diſtinguiſhed by his ſkill in the eaſtern languages. He was educated at Cambridge; where he was maſter of Catharine hall, and Arabic profeſſor; and was at length canon of Canterbury. He had the greateſt ſhare in the Polyglott Bible of London; and wrote the *Heptaglotton pro ſemptem Orientalibus*, &c. On this excellent work, which occupied a great part of his life, he beſtowed incredible pains and expence, even to the breaking of his conſtitution, and exhauſting of his fortune, having expended no leſs than 12,000l. upon that work. At length, when it was printed, the copies remained unſold upon his hands. He died in 1685; and lies buried in the churchyard of Higham Gobyon in Bedfordſhire, of which he was rector. It appears from the inſcription on his monument, which he erected in his lifetime, that he was chaplain to Charles II. He bequeathed all his oriental manuſcripts to the univerſity of Cambridge, on condition that his name ſhould be written on every copy in the collection.

CASTELLA, a town of the Mantuan, in Italy, about five miles north eaſt of the city of Mantua. E. Long. 11. 15. N. Lat. 45. 30.

CASTELLAN, the name of a dignity or charge in Poland: The caſtellans are ſenators of the kingdom, but ſenators only of the lower claſs, who, in diets, ſit on low ſeats, behind the palatines, or great ſenators. They are a kind of lieutenants of provinces, and command a part of the palatinate under the palatine.

CASTELLANY, the territory belonging to any city or town, chiefly uſed in France, and Flanders: Thus we ſay, the caſtellany of Liſle, Ypres, &c.

CASTELLARIUS, the keeper, or curator, of a caſtellum. Gruter gives an ancient ſepulchral inſcription in memory of a *caſtellarius*.

CASTELLATIO, in middle-age writers, the act of building a caſtle, or of fortifying a houſe, and rendering it a caſtle.—By the ancient Engliſh laws, caſtellation was prohibited without the king's ſpecial licenſe.

CASTELLI, Bernard, an Italian painter, was born at Genoa in 1557; and excelled in colouring and in portraits. He was the intimate friend of Taſſo, and took upon himſelf the taſk of deſigning and etching the figures of his Jeruſalem Delivered. He died at Genoa in 1629.

Valerio Caſtelli, one of his ſons, was born at Genoa in 1625, and ſurpaſſed his father. He particularly excelled in painting battles; which he compoſed with ſpirit, and executed them with ſo pleaſing a variety, and ſo great freedom of hand, as gained him univerſal applauſe. His horſes are admirably drawn, thrown into attitudes that are natural and becoming, full of motion, action, and life. In that ſtyle of painting he ſhowed all the fire of Tintoretto, united with the fine taſte of compoſition of Paolo Veroneſe. He died in 1659. The works of this maſter are not very frequent; but they are deſervedly held in very high eſteem. It is believed that a greater number of his eaſel pictures are in the collections of the nobility and gentry of England, than in any other part of Europe.

CASTELLORUM operatio, caſtle work, or ſervice and labour done by inferior tenants for the building and upholding of caſtles of defence; towards which ſome gave perſonal aſſiſtance, and others paid their contributions. This was one of the three neceſſary charges to which all lands among the Anglo-Saxons were expreſsly ſubject.

CASTELVETRO, Lewis, a native of Modena, of the 16th century, famous for his *Comment on Ariſtotle's Poetics.* He was proſecuted by the inquiſition for a certain book of Melancthon, which he had tranſlated into Italian. He retired to Baſil, where he died.

CASTIGATION, among the Romans, the puniſhment of an offender by blows, or beating with a wand or ſwitch. Caſtigation was chiefly a military puniſhment; the power of inflicting of which on the ſoldiery was given to the tribunes. Some make it of two kinds; one with a ſtick or cane, called *fuſtigatio*: the other with rods, called *flagellatio*: the latter was the moſt diſhonourable.

CASTIGATORY *for* Scolds. A woman indicted for being a common ſcold, if convicted, ſhall be placed in a certain engine of correction, called the *trebucket caſtigatory*, or *cucking ſtool*; which, in the Saxon language, ſignifies the *ſcolding ſtool*; though now it is frequently corrupted into the *ducking ſtool*; becauſe the reſidue of the judgment is, that when ſhe is placed therein, ſhe ſhall be plunged in water for her puniſhment.

CASTIGLIONE, Giovanni Benedetto, a celebrated painter, was born at Genoa in 1616. His firſt maſter was Gio-Battiſta Paggi. Afterwards he ſtudied under Andrea Ferrari; and laſtly perfected himſelf from the inſtructions of Anthony Vandyck, who at that time reſided at Genoa. He painted portraits, hiſtorical pieces, landſcapes, and caſtles; in the latter of which he is ſaid chiefly to have excelled; as alſo in fairs, markets, and all kinds of rural ſcenes. By this maſter we have alſo a great number of etchings, which are all ſpirited, free, and full of taſte. The effect is, in general, powerful and pleaſing; and many of them have a more harmonized and finiſhed appearance than is uſual from the point, ſo little aſſiſted by the graver. His drawing of the naked figure, though by no means correct, is notwithſtanding managed in a ſtyle that indicates the hand of the maſter.

His ſon, *Franceſco*, was bred under himſelf, and excelled in the ſame ſubjects; and it is thought that many good paintings which are aſcribed to Benedetto, and are frequently ſeen at ſales, or in modern collections, are copies after him by his ſon Franceſco, or perhaps originals of the younger Caſtiglione.

Castiglione, a ſmall but ſtrong town of Italy, in Mantua, with a caſtle. It was taken by the Germans in 1701, and the French defeated the Imperialiſts near it in 1706. E. Long. 10. 29. N. Lat. 43. 23.

CASTIGLIONI, Balthazar, an eminent Italian nobleman, deſcended from an illuſtrious and ancient family, and born at his own villa at Caſalico in the duchy of Milan in 1478. He ſtudied painting, ſculpture, and architecture, as appears from a book he wrote in favour of theſe arts; and excelled ſo much in them, that Raphael Urbino, and Buonaroti, though incomparable artiſts, never thought their works complete, without the approbation of Count Caſtiglioni. When he was 26 years of age, Guido Ubaldo, duke of Urbino, ſent him ambaſſador to Pope Julius II. He was ſent upon a ſecond embaſſy to Louis XII. of France, and upon a third to Henry VII. of England. After he had deſpatched his buſineſs here, he returned, and began his celebrated work, entitled *the Courtier*; which he completed at Rome in 1516. This work is full of moral and political inſtruction: and if we ſeek for the Italian tongue in perfection, it is ſaid to be no where better found than in this performance. A verſion of this work, together with the original Italian, was publiſhed at London in 1727, by A. P. Caſtiglioni, a gentleman of the ſame family, who reſided there under the patronage of Dr Gibſon, biſhop of London. Count Caſtiglioni was ſent by Clement VII. to the court of the emperor Charles V. in quality of legate, and died at Toledo in 1529.

CASTILE, New, or The Kingdom of Toledo, a province of Spain, bounded on the north by Old Caſtile, on the eaſt by the kingdoms of Arragon and Valencia, on the ſouth by thoſe of Murcia and Andaluſia, and on the weſt by the kingdom of Leon. It is divided into three parts; Argaria to the north, Mancha to the eaſt, and Sierra to the ſouth. Madrid is the capital. Both theſe provinces are very well watered with rivers, and the air is generally pure and healthy; but the land is mountainous, dry, and uncultivated, through the lazineſs of the inhabitants. The north part produces fruits and wine, and the ſouth good paſtures and fine wool. Theſe provinces are divided by a long chain of mountains, which run from eaſt to weſt.

Castile, *Old*, a province of Spain, with the title of a kingdom. It is about 192 miles in length, and 115 in breadth; bounded on the ſouth by New Caſtile, on the eaſt by Arragon and Navarre, on the north by

Biſcay and Aſturias, and on the weſt by the kingdom of Leon. Burgos is the capital town.

Castile-*de-Oro*, a large and fertile country in South America, lying to the weſt of the Oroonoko. It comprehends eight governments; viz. Terra Firma, Proper Carthagena, St Martha, Rio de la Hacha, Venezuella, New Andaluſia, Popayan, and the kingdom of New Granada.

CASTILLAN, or Castillane, a gold coin current in Spain, and worth fourteen rials and ſixteen deniers.

Castillan, is alſo a weight uſed in Spain for weighing gold. It is a hundredth part of a pound Spaniſh weight. What they commonly call a weight of gold in Spain is always underſtood of the caſtillan.

CASTILLARA, a town of the Mantuan in Italy, ſituated ſix miles north-eaſt of the city of Mantua. E. Long. 11. 25. N. Lat. 45. 20.

CASTILLON, a town of France, in the department of Gironde, ſituated on the river Dordogne, 16 miles eaſt of Bourdeaux. W. Long. 2. 40. N. Lat. 44. 50.

CASTING, in foundry, the running of metal into a mould, prepared for that purpoſe.

Casting *of Metals*, *of Letters*, *Bells*, &c. See the article Foundry.

Casting *in Sand or Earth*, is the running of metals between two frames, or moulds, filled with ſand or earth, wherein the figure that the metal is to take has been impreſſed *en creux*, by means of the pattern.

Casting, among ſculptors, implies the taking of caſts and impreſſions of figures, buſts, medals, leaves, &c.

The method of taking of caſts of figures and buſts is moſt generally by the uſe of plaſter of Paris, i. e. alabaſter calcined by a gentle heat. The advantage of uſing this ſubſtance preferably to others is, that notwithſtanding a ſlight calcination reduces it to a pulverine ſtate, it becomes again a tenacious and cohering body, by being moiſtened with water, and afterwards ſuffered to dry; by which means either a concave or a convex figure may be given by a proper mould or model to it when wet, and retained by the hardneſs it acquires when dry: and from theſe qualities, it is fitted for the double purpoſe of making both caſts, and moulds for forming thoſe caſts. The particular manner of making caſts depends on the form of the ſubject to be taken. Where there are no projecting parts, it is very ſimple and eaſy; as likewiſe where there are ſuch as form only a right or any greater angle with the principal ſurface of the body; but where parts project in leſſer angles, or form a curve inclined towards the principal ſurface of the body, the work is more difficult.

The firſt ſtep to be taken is the forming the mould. In order to this, if the original or model be a baſs relief, or any other piece of a flat form, having its ſurface firſt well greaſed, it muſt be placed on a proper table, and ſurrounded by a frame, the ſides of which muſt be at ſuch a diſtance from it as will allow a proper thickneſs for the ſides of the mould. As much plaſter as will be ſufficient to cover and riſe to ſuch a thickneſs as may give ſufficient ſtrength to the mould, as alſo to fill the hollow betwixt the frame and the model, muſt be moiſtened with water, till it be juſt of ſuch conſiſtence as will allow it to be poured upon the model. This muſt be done as ſoon as poſſible; or the plaſter would concrete or ſet, ſo as to become more troubleſome in the working, or unfit to be uſed. The whole muſt then be ſuffered to remain in this condition, till the plaſter has attained its hardneſs; and then the frame being taken away, the preparatory caſt or mould thus formed may be taken off from the ſubject entire.

Where the model or original ſubject is of a round or erect form, a different method muſt be purſued; and the mould muſt be divided into ſeveral pieces: or if the ſubject conſiſts of detached and projecting parts, it is frequently moſt expedient to caſt ſuch parts ſeparately, and afterwards join them together.

Where the original ſubject or mould forms a round, or ſpheroid, or any part of ſuch round or ſpheroid, more than one half the plaſter muſt be uſed without any frame to keep it round the model; and muſt be tempered with water to ſuch a conſiſtence, that it may be wrought with the hand like very ſoft paſte; but though it muſt not be ſo fluid as when prepared for flat-figured models, it muſt yet be as moiſt as is compatible with its cohering ſufficiently to hold together; and being thus prepared, it muſt be put upon the model, and compreſſed with the hand, or any flat inſtrument, that the parts of it may adapt themſelves, in the moſt perfect manner, to thoſe of the ſubject, as well as to be compact with reſpect to themſelves. When the model is ſo covered to a convenient thickneſs, the whole muſt be left at reſt till the plaſter be ſet and firm, ſo as to bear dividing without falling to pieces, or being liable to be put out of its form by ſlight violence; and it muſt then be divided into pieces, in order to its being taken off from the model, by cutting it with a knife with a very thin blade: and being divided, muſt be cautiouſly taken off, and kept till dry; but it muſt be always carefully obſerved, before the ſeparation of the parts be made, to notch them acroſs the joints or lines of the diviſion, at proper diſtances, that they may with eaſe and certainty be properly conjoined again; which would be much more precarious and troubleſome without ſuch directive marks. The art of properly dividing the moulds, in order to make them ſeparate from the model, requires more dexterity and ſkill than any other thing in the art of caſting; and does not admit of rules for the moſt advantageous conduct of it in every caſe. Where the ſubject is of a round or ſpheroidal form, it is beſt to divide the mould into three parts, which will then eaſily come off from the model: and the ſame will hold good of a cylinder or any regular curved figure.

The mould being thus formed, and dry, and the parts put together, it muſt be firſt greaſed, and placed in ſuch a poſition that the hollow may lie upwards, and then filled with plaſter mixed with water, in the ſame proportion and manner as was directed for the caſting the mould: and when the caſt is perfectly ſet and dry, it muſt be taken out of the mould, and repaired where it is neceſſary; which finiſhes the operation.

This is all that is required with reſpect to ſubjects where the ſurfaces have the regularity above-mentioned: but where they form curves which interſect each other, the conduct of the operation muſt be varied with reſpect to the manner of taking the caſt of the

the mould from off the ſubject or model; and where there are long projecting parts, ſuch as legs or arms, they ſhould be wrought in ſeparate caſts. The operator may eaſily judge, from the original ſubjects, what parts will come off together, and what require to be ſeparated: the principle of the whole conſiſts only in this, that where under-workings, as they are called, occur, that is, wherever a ſtraight line drawn from the baſis or inſertion of any projection, would be cut or croſſed by any part of ſuch projection, ſuch part cannot be taken off without a diviſion; which muſt be made either in the place where the projection would croſs the ſtraight line; or, as that is frequently difficult, the whole projection muſt be ſeparated from the main body, and divided alſo lengthwiſe into two parts; and where there are no projections from the principal ſurfaces, but the body is ſo formed as to render the ſurface a compoſition of ſuch curves, that a ſtraight line being drawn parallel to the ſurface of one part would be cut by the outline, in one or more places, of another part, a diviſion of the whole ſhould be made, ſo as to reduce the parts of it into regular curves, which muſt then be treated as ſuch.

In larger maſſes, where there would otherwiſe be a great thickneſs of the plaſter, a core or body may be put within the mould, in order to produce a hollow in the caſt; which both ſaves the expence of the plaſter, and renders the caſt lighter.

This core may be of wood, where the forming a hollow of a ſtraight figure, or a conical one with the baſis outward, will anſwer the end: but if the cavity require to be round, or of any curve figure, the core cannot be then drawn while entire; and conſequently ſhould be of ſuch matter as may be taken out piecemeal. In this caſe, the core is beſt formed of clay; which muſt be worked upon wires to give it a tenacity, and ſuſpended in the hollow of the mould by croſs wires lying over the mouth; and when the plaſter is ſufficiently ſet to bear handling, the clay muſt be picked out by a proper inſtrument.

Where it is deſired to render the plaſter harder, the water with which it is tempered ſhould be mixed with parchment ſize properly prepared, which will make it very firm and tenacious.

In the ſame manner, figures, buſts, &c. may be caſt of lead, or any other metal, in the moulds of plaſter; only the expence of plaſter, and the tedioufneſs of its becoming ſufficiently dry, when in a very large maſs, to bear the heat of melted metal, render the uſe of clay, compounded with ſome other proper materials, preferable where large ſubjects are in queſtion. The clay, in this caſe, ſhould be waſhed over till it be perfectly free from gravel or ſtones; and then mixed with a third or more of fine ſand to prevent it cracking; or, inſtead of ſand, coal aſhes ſifted-fine may be uſed. Whether plaſter or clay be employed for the caſting in metal, it is extremely neceſſary to have the mould perfectly dry: otherwiſe the moiſture, being rarefied, will make an exploſion that will blow the metal out of the mould, and endanger the operator, or at leaſt crack the mould in ſuch a manner as to fruſtrate the operation. Where the parts of a mould are larger, or project much, and conſequently require a greater tenacity of the matter they are formed of to keep them together, flocks of cloth, prepared like thoſe deſigned for paper hangings, or fine cotton plucked or cut till it is very ſhort, ſhould be mixed with the aſhes or ſand before they are added to the clay to make the compoſition for the mould. The proportion ſhould be according to the degree of coheſion required; but a ſmall quantity will anſwer the end, if the other ingredient of the compoſition be good, and the parts of the mould properly linked together by means of the wires above directed.

There is a method of taking caſts in metals from ſmall animals, and the parts of vegetables, which may be practiſed for ſome purpoſes with advantage: particularly for the decorating grottoes or rock work, where nature is imitated. The proper kinds of animals are lizards, ſnakes, frogs, birds or inſects; the caſts of which, if properly coloured, will be exact repreſentations of the originals.

This is to be performed by the following method: A coffin or proper cheſt for forming the mould being prepared of clay, or four pieces of boards fixed together, the animal or parts of vegetables muſt be ſuſpended in it by a ſtring; and the leaves, tendrils or other detached parts of the vegetables, or the legs, wings, &c. of the animals, properly ſeparated and adjuſted, in their right poſition by a ſmall pair of pincers: a due quantity of plaſter of Paris and calcined talk, in equal quantities, with ſome alumen plumoſum, muſt then be tempered with water to the proper conſiſtence for caſting; and the ſubject from whence the caſt is to be taken, alſo the ſides of the coffin, moiſtened with ſpirit of wine. The coffin or cheſt muſt then be filled with the tempered compoſition of the plaſter and talk, putting at the ſame time a piece of ſtraight ſtick or wood to the principal part of the body of the ſubject, and pieces of thick wire to the extremities of the other parts, in order that they may form, when drawn out after the matter of the mould is properly ſet and firm, a channel for pouring in the melted metal, and vents for the air; which otherwiſe by the rarefaction it would undergo from the heat of the metal would blow it out or burſt the mould. In a ſhort time the plaſter and talk will ſet and become hard, when the ſtick and wires may be drawn out, and the frame or coffin in which the mould was caſt taken away: and the mould muſt then be put firſt into a moderate heat, and afterwards, when it is as dry as it can be rendered by that degree, removed into a greater; which may be gradually increaſed till the whole be red hot. The animal or part of any vegetable, which was included in the mould, will then be burnt to a coal; and may be totally calcined to aſhes, by blowing for ſome time gently into the channel and paſſages made for pouring in the metal, and giving vent to the air, which will, at the ſame time that it deſtroys the remainder of the animal or vegetable matter, blow out the aſhes. The mould muſt then be ſuffered to cool gently; and will be perfect; the deſtruction of the ſubſtance of the animal or vegetable having produced a hollow of a figure correſpondent to it: but it may be nevertheleſs proper to ſhake the mould, and turn it upſide down, as alſo to blow with the bellows into each of the air-vents, in order to free it wholly from any remainder of the aſhes; or where there may be an opportunity of filling the hollow with quickſilver without expence, it will be found a very effectual method of clearing the cavity, as all duſt, aſhes, or ſmall detached bodies, will neceſſarily riſe to the ſurface of the quickſilver, and be poured out with it. The mould being thus prepared, it muſt be heated very hot when uſed, if the caſt be made with copper or braſs: but a leſs degree will ſerve for lead or tin; and the matter being poured in, the mould muſt be gently ſtruck; and then ſuffered to reſt till it be cold; at which time it muſt be carefully taken from the caſt, but without the leaſt force; for ſuch parts of the matter as appear to adhere more ſtrongly, muſt be ſoftened by ſoaking in water till they be entirely looſened, that none of the more delicate parts of the caſt may be broken off or bent.

Where the alumen plumoſum, or talk, cannot eaſily be procured, the plaſter may be uſed alone; but it is apt to be calcined by the heat uſed in burning the animal or vegetable from whence the caſt is taken, and to become of too incohering and crumbly texture; or, for cheapneſs, Sturbridge or any other good clay, waſhed over, till it be perfectly fine, and mixed with an equal part of ſand, and ſome flocks cut ſmall, may be employed. Pounded pumice ſtone and plaſter of Paris, taken in equal quantities, and mixed with waſhed clay in the ſame proportion, is ſaid to make excellent moulds for this and parallel uſes.

Caſts of medals, or ſuch ſmall pieces as are of a ſimilar form, may be made in plaſter by the method directed for baſs relievos.

Indeed there is nothing more required than to form a mould by laying them on a proper board, and having ſurrounded them by a rim made by the piece of a card or any other paſteboard, to fill the rim with ſoft tempered plaſter of Paris; which mould, when dry, will ſerve for ſeveral caſts. It is nevertheleſs a better method to form the mould of melted ſulphur; which will produce a ſharper impreſſion in the caſt, and be more durable than thoſe made of plaſter.

The caſts are likewiſe frequently made of ſulphur, which being melted muſt be treated exactly in the ſame manner as the plaſter.

Phil. Comm. of Arts.

For taking caſts from medals, Dr Lewis recommends a mixture of flowers of brimſtone and red lead: equal parts of theſe are to be put over the fire in a ladle, till they ſoften to the conſiſtence of pap: then they are kindled with a piece of paper, and ſtirred for ſome time. The veſſel being afterwards covered cloſe, and continued on the fire, the mixture grows fluid in a few minutes. It is then to be poured on the metal, previouſly oiled and wiped clean. The caſts are very neat; their colour ſometimes a pretty deep black, ſometimes a dark grey: they are very durable; and when ſoiled, may be waſhed clean in ſpirits of wine.

Naturaliſts Companion.

Dr Lettſom recommends tin foil for taking off caſts from medals. The thinneſt kind is to be uſed. It ſhould be laid over the ſubject from which the impreſſion is to be taken, and then rubbed with a bruſh, the point of a ſkewer, or a pin, till it has perfectly received the impreſſion. The tin foil ſhould now be pared cloſe to the edge of the medal, till it is brought to the ſame circumference: the medal muſt then be reverſed, and the tin foil will drop off into a chip box or mould placed ready to receive it. Thus the concave ſide of the foil will be uppermoſt, and upon this plaſter of Paris, prepared in the uſual manner, may be poured. When dry, the whole is to be taken out, and the tin foil ſticking on the plaſter will give a perfect repreſentation of the medal, almoſt equal in beauty to ſilver. If the box or mould is a little larger than the medal, the plaſter running round the tin foil will give the appearance of a white frame or circular border; whence the new made medal will appear more neat and beautiful.

Caſts may be made likewiſe with iron, prepared in the following manner: "Take any iron bar, or piece of a ſimilar form; and having heated it red-hot, hold it over a veſſel containing water, and touch it very ſlightly with a roll of ſulphur, which will immediately diſſolve it, and make it fall in drops into the water. As much iron as may be wanted being thus diſſolved, pour the water out of the veſſel? and pick out the drops formed by the melted iron from thoſe of the ſulphur, which contain little or no iron, and will be diſtinguiſhable from the other by their colour and weight." The iron will, by this means, be rendered ſo fuſible, that it will run with leſs heat than is required to melt lead; and may be employed for making caſts of medals, and many other ſuch purpoſes, with great convenience and advantage.

Impreſſions of medals having the ſame effect as caſts, may be made alſo of iſinglaſs glue, by the following means. Melt the iſinglaſs, beaten, as when commonly uſed, in an earthen pipkin, with the addition of as much water as will cover it, ſtirring it gently till the whole is diſſolved; then with a bruſh of camels hair, cover the medal, which ſhould be previouſly well cleanſed and warmed, and then laid horizontally on a board or table, greaſed in the part around the medal. Let them reſt afterwards till the glue be properly hardened; and then, with a pin, raiſe the edge of it; and ſeparate it carefully from the medal: the caſt will be thus formed by the glue as hard as horn; and ſo light, that a thouſand will ſcarcely weigh an ounce. In order to render the relief of the medal more apparent, a ſmall quantity of carmine may be mixed with the melted iſinglaſs; or the medal may be previouſly coated with leaf gold by breathing on it, and then laying it on the leaf, which will by that means adhere to it; but the uſe of leaf gold is apt to impair a little the ſharpneſs of the impreſſion.

Impreſſions of medals may be likewiſe taken in putty; but it ſhould be the true kind made of calx of tin, and drying oil. Theſe may be formed in the moulds, previouſly taken in plaſter or ſulphur; or moulds may be made in its own ſubſtance, in the manner directed for thoſe of the plaſter. Theſe impreſſions will be very ſharp and hard; but the greateſt diſadvantage that attends them, is their drying very ſlowly, and being liable in the mean time to be damaged.

Impreſſions of prints, or other engravings, may be taken from copperplates, by cleanſing them thoroughly, and pouring plaſter upon them; but the effect in this way is not ſtrong enough for the eye; and therefore the following method is preferable, where ſuch impreſſions on plaſter are deſired.

Take vermillion, or any other coloured pigment, finely powdered, and rub it over the plate: then paſs a folded piece of paper, or the flat part of the hand, over the plate to take off the colour from the lights or parts where there is no engraving; the proceeding muſt then be the ſame as where no colour is uſed. This laſt method is alſo applicable to the making of impreſſions of copperplates on paper with dry colours; for the plate being prepared as here directed, and laid on the paper properly moiſtened, and either paſſed under the rolling preſs, or any other way ſtrongly forced down on the paper, an impreſſion of the engraving will be obtained.

Impreſſions may be likewiſe taken from copperplates, either on plaſter or paper, by means of the ſmoke of a candle or lamp; if, inſtead of rubbing them with any colour, the plate be held over the candle or lamp till the whole ſurface become black, and then wiped off by the flat of the hand, or paper.

Theſe methods are not, however, of great uſe in the caſe of copperplates, except where impreſſions may be deſired on occaſions where printing ink cannot be procured: but as they may be applied likewiſe to the taking impreſſions from ſnuff boxes, or other engraved ſubjects, by which means deſigns may be inſtantly borrowed by artiſts or curious perſons, they may in ſuch inſtances be very uſeful.

The expedient of taking impreſſions by the ſmoke of a candle or lamp may be employed alſo for botanical purpoſes in the caſe of leaves, as a perfect and durable repreſentation of not only the general figure, but the contexture and diſpoſition of the larger fibres, may be extemporaneouſly obtained at any time. The ſame may be nevertheleſs done in a more perfect manner, by the uſe of linſeed oil, either alone or mixed with a ſmall proportion of colour, where the oil can be conveniently procured: but the other method is valuable on account of its being practicable at almoſt all ſeaſons, and in all places, within the time that the leaves will keep freſh and plump. In taking theſe impreſſions it is proper to bruiſe the leaves, ſo as to take off the projections of the large ribs, which might prevent the other parts from plying to the paper.

Leaves, as alſo the petals, or flower leaves, of plants, may themſelves be preſerved on paper, with their original appearance, for a conſiderable length of time, by the following means.—Take a piece of paper, and rub it over with iſinglaſs glue treated as above directed for taking impreſſions from medals; and then lay the leaves in a proper poſition on the paper. The glue laid on the paper being ſet, bruſh over the leaves with more of the ſame; and that being dry likewiſe, the operation will be finiſhed, and the leaves ſo ſecured from the air and moiſture, that they will retain their figure and colour much longer than by any other treatment.

Butterflies, or other ſmall animals of a flat figure, may alſo be preſerved in the ſame manner.

Casting is alſo ſometimes uſed for the quitting, laying, or throwing aſide any thing; thus deer caſt their horns, ſnakes their ſkins, lobſters their ſhells, hawks their feathers, &c. annually.

Caſting of feathers is more properly called *moulting* or *mewing*.

A horſe *caſts* his hair, or coat, at leaſt once a-year, viz. in the ſpring, when he caſts his winter coat; and ſometimes, at the cloſe of autumn, he caſts his ſummer coat, in caſe he has been ill kept. Horſes alſo ſometimes *caſt* their hoofs, which happens frequently to coach horſes brought from Holland; theſe being bred in a moiſt marſhy country, have their hoofs too flabby: ſo that coming into a drier ſoil, and leſs juicy provender, their hoofs fall off, and others that are firmer ſucceed.

Casting *a Colt*, denotes a mare's proving abortive.

Casting *Net*, a ſort of fiſhing net, ſo called, becauſe it is to be *caſt* or thrown out; which when exactly done, nothing eſcapes it, but weeds and every thing within its extent are brought away.

CASTLE, a fortreſs or place rendered defenſible either by nature or art. It frequently ſignifies with us the principal manſion of noblemen. In the time of Henry II. there were no leſs than 1115 caſtles in England, each of which contained a manor.

Castles, walled with ſtone, and deſigned for reſidence as well as defence, are for the moſt part, according to Mr Groſe, of no higher antiquity than the Conqueſt; for although the Saxons, Romans, and even, according to ſome writers on antiquity, the ancient Britons, had caſtles built with ſtone; yet theſe were both few in number, and at that period, through neglect or invaſions, either deſtroyed or ſo much decayed, that little more than their ruins were remaining. This is aſſerted by many of our hiſtorians and antiquaries, and aſſigned as a reaſon for the facility with which William made himſelf maſter of this country.

This circumſtance was not overlooked by ſo good a general as the Conqueror; who, effectually to guard againſt invaſions from without, as well as to awe his newly acquired ſubjects, immediately bagan to erect caſtles all over the kingdom, and likewiſe to repair and augment the old ones. Beſides, as he had parcelled out the lands of the Engliſh amongſt his followers, they, to protect themſelves from the reſentment of thoſe ſo deſpoiled, built ſtrong holds and caſtles on their eſtates. This likewiſe cauſed a conſiderable increaſe of theſe fortreſſes; and the turbulent and unſettled ſtate of the kingdom in the ſucceeding reigns, ſerved to multiply them prodigiouſly, every baron or leader of a party building caſtles; inſomuch, that towards the latter end of the reign of King Stephen, they amounted to the almoſt incredible number of 1115.

As the feudal ſyſtem gathered ſtrength, theſe caſtles became the heads of baronies. Each caſtle was a manor: and its caſtelain, owner, or governor, the lord of that manor. Markets and fairs were directed to be held there; not only to prevent frauds in the king's duties or cuſtoms, but alſo as they were eſteemed places where the laws of the land were obſerved, and as ſuch had a very particular privilege. But this good order did not long laſt: for the lords of caſtles began to arrogate to themſelves a royal power, not only within their caſtles, but likewiſe its environs; exerciſing judicature both civil and criminal, coining of money, and arbitrarily ſeizing forage and proviſion for the ſubſiſtence of their garriſons, which they afterwards demanded as a right: at length their inſolence and oppreſſion grew to ſuch a pitch, that, according to William of Newbury, "there were in England as many kings, or rather tyrants, as lords of caſtles;" and Matthew Paris ſtyles

Groſe's Antiquities of England and Wales, vol. i. Preface.

ſtyles them very neſts of devils, and dens of thieves. Caſtles were not ſolely in the poſſeſſion of the crown and the lay barons, but even biſhops had theſe fortreſſes; though it ſeems to have been contrary to the canons, from a plea made uſe of in a general council, in favour of King Stephen, who had ſeized upon the ſtrong caſtles of the biſhops of Lincoln and Saliſbury. This prohibition (if ſuch exiſted) was, however, very little regarded; as in the following reigns many ſtrong places were held, and even defended, by the eccleſiaſtics: neither was more obedience afterwards paid to a decree made by the pope at Viterbo, the fifth of the kalends of June 1220, wherein it was ordained, that no perſon in England ſhould keep in his hands more than two of the king's caſtles.

The licentious behaviour of the garriſons of theſe places becoming intolerable, in the treaty between King Stephen and Henry II. when only duke of Normandy, it was agreed, that all the caſtles built within a certain period ſhould be demoliſhed; in conſequence of which many were actually raſed, but not the number ſtipulated.

The few caſtles in being under the Saxon government, were probably, on occaſion of war or invaſions, garriſoned by the national militia, and at other times ſlightly guarded by the domeſtics of the princes or great perſonages who reſided therein; but after the Conqueſt, when all the eſtates were converted into baronies held by knight's ſervice, caſtle guard coming under that denomination, was among the duties to which particular tenants were liable. From theſe ſervices the biſhops and abbots, who till the time of the Normans had held their lands in frank almoign, or free alms, were, by this new regulation, not exempted; they were not indeed, like the laity, obliged to perſonal ſervice, it being ſufficient that they provided fit and able perſons to officiate in their ſtead. This was however at firſt ſtoutly oppoſed by Anſelm archbiſhop of Canterbury; who being obliged to find ſome knights to attend King William Rufus in his wars in Wales, complained of it as an innovation and infringement of the rights and immunities of the church.

It was no uncommon thing for the Conqueror and the kings of thoſe days to grant eſtates to men of approved fidelity and valour, on condition that they ſhould perform caſtle guard in the royal caſtles, with a certain number of men, for ſome ſpecified time; and ſometimes they were likewiſe bound by their tenures to keep in repair and guard ſome particular tower or bulwark, as was the caſe at Dover caſtle.

In proceſs of time theſe ſervices were commuted for annual rents, ſometimes ſtyled *wardpenny*, and waytfee, but commonly *caſtleguard* rents, payable on fixed days, under prodigious penalties called *ſurſizes*. At Rocheſter, if a man failed in the payment of his rent of caſtle guard on the feaſt of St Andrew, his debt was doubled every tide during the time for which the payment was delayed. Theſe were afterwards reſtrained by an act of parliament made in the reign of King Henry VIII. and finally annihilated, with the tenures by knight's ſervice in the time of Charles II. Such caſtles as were private property were guarded either by mercenary ſoldiers, or the tenants of the lord or owner.

Caſtles which belonged to the crown, or fell to it either by forfeiture or eſcheat, (circumſtances that frequently happened in the diſtracted reigns of the feudal times), were generally committed to the cuſtody of ſome truſty perſon, who ſeems to have been indifferently ſtyled governor and conſtable. Sometimes alſo they were put into the poſſeſſion of the ſheriff of the county, who often converted them into priſons. That officer was then accountable at the exchequer, for the farm or produce of the lands belonging to the places intruſted to his care, as well as all other profits; he was likewiſe, in caſe of war or invaſion, obliged to victual and furniſh them with munition out of the iſſues of his county; to which he was directed by writ of privy ſeal.

The materials of which caſtles were built, varied according to the places of their erection: but the manner of their conſtruction ſeems to have been pretty uniform. The outſides of the walls were generally built with the ſtones neareſt at hand, laid as regularly as their ſhapes would admit; the inſides were filled up with the like materials, mixed with a great quantity of fluid mortar, which was called by the workmen groutwork.

The general ſhape or plan of theſe caſtles depended entirely on the caprice of the architects, or the form of the ground intended to be occupied; neither do they ſeem to have confined themſelves to any particular figure in their towers; ſquare, round, and polygonal, oftentimes occurring in the original parts of the ſame building.

The ſituation of the caſtles of the Anglo-Norman kings and barons was moſt commonly on an eminence, and near a river; a ſituation on ſeveral accounts eligible. The whole ſite of the caſtle (which was frequently of great extent and irregular figure) was ſurrounded by a deep and broad ditch, ſometimes filled with water, and ſometimes dry, called the *foſſe*. Before the great gate was an outwork, called a *barbacan*, or *antemural*, which was a ſtrong and high wall, with turrets upon it, deſigned for the defence of the gate and drawbridge. On the inſide of the ditch ſtood the wall of the caſtle, about eight or ten feet thick, and between 20 and 30 feet high, with a parapet, and a kind of embraſures called *crennels*, on the top. On this wall, at proper diſtances, ſquare towers of two or three ſtories high were built, which ſerved for lodging ſome of the principal officers of the proprietor of the caſtle, and for other purpoſes: and on the inſide were erected lodgings for the common ſervants or retainers, granaries, ſtorehouſes, and other neceſſary offices. On the top of this wall, and on the flat roofs of theſe buildings, ſtood the defenders of the caſtle, when it was beſieged, and from thence diſcharged arrows, darts, and ſtones on the beſiegers. The great gate of the caſtle ſtood in the courſe of this wall, and was ſtrongly fortified with a tower on each ſide, and rooms over the paſſage, which was cloſed with thick folding doors of oak, often plated with iron, and with an iron portcullis or grate let down from above. Within this outward wall was a large open ſpace or court, called, in the largeſt and moſt perfect caſtles, the *outer bayle*, or *ballium*, in which ſtood commonly a church or chapel. On the inſide of this outer bayle was another ditch, wall, gate, and towers, encloſing the inner bayle or court, within which the chief tower or *keep* was built. This was a very large ſquare fabric, four or five ſtories high, having ſmall windows in prodigious thick walls, which rendered the apartments within it dark and gloomy. This great tower was the palace of the prince, prelate, or baron, to whom the caſtle belonged, and the reſidence of the conſtable or governor. Under ground were diſmal dark vaults, for the confinement of priſoners, which made it ſometimes be called the *dungeon*. In this building alſo was the great hall, in which the owner diſplayed his hoſpitality, by entertaining his numerous friends and followers. At one end of the great halls of caſtles, palaces, and monaſteries, there was a place raiſed a little above the reſt of the floor, called the *deis*, where the chief table ſtood, at which perſons of the higheſt rank dined. Though there were unqueſtionably great variations in the ſtructure of caſtles, yet the moſt perfect and magnificent of them ſeem to have been conſtructed nearly on the above plan. Such, to give one example, was the famous caſtle of Bedford, as appears from the following account of the manner in which it was taken by Henry III. A. D. 1224. The caſtle was taken by four aſſaults. "In the firſt was taken the barbacan; in the ſecond the outer ballia; at the third attack, the wall by the old tower was thrown down by the miners, where, with great danger, they poſſeſſed themſelves of the inner ballia, through a chink; at the fourth aſſault the miners ſet fire to the tower, ſo that the ſmoke burſt out, and the tower itſelf was cloven to that degree, as to ſhow viſibly ſome broak chinks: whereupon the enemy ſurrendered." See a repreſentation of a caſtle in Plate CXXXV. where 1 is the barbacan, 2 the ditch or moat, 3 the wall of the outer ballium, 4 the outer ballium, 5 the artificial mount, 6 the wall of the inner ballium, 7 the inner ballium, 8 the keep or dungeon.

Before the acceſſion of James VI. to the throne of England, the ſituation of Scotland was ſuch, that every baron's houſe was more or leſs fortified, according to the power or conſequence of its lord, or according to the ſituation of the caſtle. Near Edinburgh or Stirling, where the inhabitants were more poliſhed in their manners, and overawed by the ſeat of government, no more was neceſſary than towers capable of reſiſting the curſory attack of robbers and thieves, who never durſt ſtop to make a regular inveſtment, but plundered by ſurpriſe, and, if repulſed, inſtantly fled away. Such was Melville Caſtle. It anciently conſiſted of a ſtrong built tower of three ſtories, embattled at the top, and was ſufficiently ſtrong to reſiſt a ſudden attack, unaided by artillery, or other engines of war. But, when further removed, as in Perthſhire, Inverneſsſhire, or Aberdeenſhire, then it was neceſſary to be better defended, and the aids of a peel or dungeon, with outer walls, moat, and wet ditch, barnakin, &c. added to enable the powerful lord to reſiſt the formidable attack of his powerful adverſary. The hiſtory of Scotland, ſo late as the reign of the Stuart family, affords a number of melancholy inſtances of inveterate feuds among the greater and leſſer barons of that period; by which every mode of fortification then in uſe was ſeldom adequate to the defence of the caſtle againſt the ſtorm or blockade of the enraged chieftain. The caſtle of Doun ſeems to anſwer this deſcription of fortification, and has made ſeveral gallant defences, in the annals of Scotland. The third kind of fortreſſes we meet with in Scotland are thoſe ſituated on the borders of England, or on the ſea coaſts of the kingdom, and in the weſtern iſles, and very remote places. Many of the old caſtles in Scotland were ſituated on an iſland, in a deep lake, or on a peninſula, which by a broad deep cut was made an iſland. Of this kind was Lochmaben, in the ſtewartry of Annandale, the caſtle of Cloſeburn in the ſhire of Nithſdale, the caſtle of the Rive, ſituated on the river Dee in the ſhire of Galloway, Lochleven caſtle, and many others.

This kind of fortreſs was only acceſſible in a hard froſt, or by boats, which were not eaſily tranſported by a people deſtitute of good roads and wheel carriages. In fact, they could only be taken by ſurpriſe or blockade; the firſt very difficult, the ſecond very tedious; ſo that, before the uſe of artillery, they might be deemed almoſt impregnable. On that account, their ſituation was very deſirable in the inland parts of Scotland.

On the ſea coaſts of Scotland we generally find the ſtrongeſt and moſt ancient, as well as the moſt impregnable caſtles. Theſe had to defend themſelves from the invaſion of the foreign enemy, as well as the attacks of the domeſtic foe. Thus we find the barons, whoſe lands extended to the ſea coaſt, perched, like the eagle, on the moſt inacceſſible rocks that lay within their poſſeſſions. Of this kind were Slains caſtle, Tantallon and Dunottar, on the eaſt coaſt, and Dunvegan in the iſle of Sky, with Dunolly on the weſt coaſt. Theſe muſt have been moſt uncomfortable retreats, except to a barbarous people, or when a preſſing danger forced the baron to ſeek his ſafety in the only poſſible retreat left him.

CASTLE, in ancient writers, denotes a town or village ſurrounded with a ditch and wall, furniſhed with towers at intervals, and guarded by a body of troops. The word is originally Latin, *caſtellum*, a diminutive from *caſtrum*. *Caſtellum* originally ſeems to have ſignified a ſmaller fort for a little garriſon: though Suetonius uſes the word ,where the fortification was large enough to contain a cohort. The *caſtella*, according to Vegetius, were often like towns, built on the borders of the empire, and where there were conſtant guards and fences againſt the enemy. Horſley takes them for much the ſame with what were otherwiſe denominated *ſtations*.

CASTLE, or *Caſtle-ſteed*, is alſo an appellation given by the country people in the north to the Roman *caſtella*, as diſtinguiſhed from the *caſtra ſtativa* which they uſually call *cheſters*. Horſley repreſents this as an uſeful criterion, whereby to diſcover or diſtinguiſh a Roman camp or ſtation. There are ſeveral of theſe caſtella on Severus's wall: they are generally 60 feet ſquare; their north ſide is formed by the wall itſelf, which falls in with them; the intervals between them are from ſix furlongs and a half to ſeven; they ſeem to have ſtood cloſeſt where the ſtations are wideſt. The neighbouring people call them *caſtles*, or *caſtle ſteeds*, by which it ſeems probable that their ancient Latin name had been *caſtellum*. Some modern writers call them *mile caſtles*, or military *caſtellæ*; Horſley ſometimes *exploratory caſtles*. In theſe *caſtella* the *areans* had their ſtation, who were an order of men whoſe buſineſs was to make incurſions into the enemy's country, and give intelligence of their motions.

CASTLE, in the ſea language, is a part of the ſhip, of which there are two ; the forecaſtle, being the elevation at the prow, or the uppermoſt deck towards the mizen, the place where the kitchens are. Hindcaſtle is the elevation which reigns on the ſtern, over the laſt deck, where the officers cabins and places of aſſembly are.

Castle, *Edmund.* See Castel.

Castle-Bar, a borough and market town, capital of the county of Mayo in Ireland, is a well-inhabited place, and carries on a briſk trade : it has a barrack for a troop of horſe ; and there is here a charter ſchool capable of receiving 50 children, and endowed with two acres of land, rent free, by the right honourable Lord Lucan, who has alſo granted a leaſe of 20 acres more at a pepper corn yearly.

Castle-Cary, a remarkable Roman ſtation about four miles weſt from Falkirk on the borders of Stirlingſhire in Scotland. It comprehends ſeveral acres of ground, is of a ſquare form, and is ſurrounded with a wall of ſtone and mortar : all the ſpace within the walls has been occupied by buildings, the ruins of which have raiſed the earth eight or ten feet above its natural ſurface ; ſo that the fort now ſeems like a hill top ſurrounded with a ſunk fence. In 1770, ſome workmen employed in ſearching for ſtones for the great canal, which paſſes very near it, diſcovered ſeveral apartments of ſtone ; and in one of them a great number of ſtones about two feet in length, and ſtanding erect, with marks of fire upon them, as if they had been employed in ſupporting ſome veſſel under which fire was put. In a hollow of the rock near this place, in 1771, a conſiderable quantity of wheat quite black with age was found, with ſome wedges and hammers ſuppoſed to be Roman.

Castle-Riſing, a borough town of Norfolk in England, which ſends two members to parliament. E. Long. 0. 40. N. Lat. 52. 46.

Castle-Work, ſervice or labour done by inferior tenants, for the building and upholding caſtles of defence, toward which ſome gave their perſonal aſſiſtance, and others paid their contributions. This was one of the three neceſſary charges to which the Anglo-Saxons were expreſsly ſubject.

CASTLETOWN, the capital of the iſle of Man, ſeated on the ſouth-weſt part of the iſland. It has a ſtrong caſtle ; but of no great importance, on account of its diſtance from the rocky and ſhallow harbour. W. Long. 4. 39. N. Lat. 53. 30.

CASTOR, the Beaver, in *Zoology*, a genus of quadrupeds belonging to the order of glires. See Mammalia *Index*.

Castor, in *Aſtronomy*, a moiety of the conſtellation Gemini ; called alſo Apollo. Its latitude northwards, for the year 1700, according to Hevelius, was 10° 4′ 23″ ; and its longitude, of Cancer, 17° 4′ 14″. It is alſo called Raſalgenze, Apollo, Aphellan, Avellar, and Anelar.

Castor and Pollux, in Pagan mythology. Jupiter having an amour with Leda, the wife of Tyndarus king of Sparta, in the form of a ſwan, ſhe brought forth two eggs, each containing twins. From that impregnated by Jupiter proceeded Pollux and Helena, who were both immortal : from the other Caſtor and Clytemneſtra, who being begot by Tyndarus were both mortal. They were all, however, called by the common name of *Tyndaridæ*. Theſe two brothers entered into an inviolable friendſhip ; they went with the other noble youths of Greece in the expedition to Colchis, and on ſeveral occaſions ſignalized themſelves by their courage ; but Caſtor being at length killed, Pollux obtained leave to ſhare his own immortality with him ; ſo that they are ſaid to live and die alternately every day : for, being tranſlated into the ſkies, they form the conſtellation of Gemini, one of which ſtars riſes as the other ſets

A martial dance, called the *Pyrrhic* or *Caſtorian* dance, was invented in honour of thoſe deities. whom the Cephelenſes placed among the Dii Magni, and offered to them white lambs. The Romans alſo paid them particular honours on account of the aſſiſtance they are ſaid to have given them in an engagement againſt the Latins ; in which, appearing mounted on white horſes, they turned the ſcale of victory in their favour, for which a temple was erected to them in the forum.

Castor and Pollux, a fiery meteor, which at ſea appears ſometimes ſticking to a part of the ſhip, in form of one, two, or even three or four fire-balls : when one is ſeen alone, it is more properly called *Helena* ; two are denominated Caſtor and Pollux, and ſometimes Tyndaridæ. Caſtor and Pollux are called by the Spaniards, San Elmo ; by the French St Elme, St Nicholas, St Clare, St Helene ; by the Italians, Hermo ; by the Dutch, Tree Vuuren.

Caſtor and Pollux are commonly judged to portend a ceſſation of the ſtorm, and a future calm ; being rarely ſeen till the tempeſt is nigh ſpent. Helena alone portends ill, and witneſſes the ſevereſt part of the ſtorm yet behind. When the meteor ſticks to the maſts, yards, &c. they conclude, from the air's not having motion enough to diſſipate this flame, that a profound calm is at hand ; if it flutter about, it indicates a ſtorm.

CASTOREUM, in the *Materia Medica*, castor ; the inguinal glands of the beaver. The ancients had a notion that it was lodged in the teſticles ; and that the animal, when hard preſſed, would bite them off, and leave them to its purſuers, as if conſcious of what they wanted to deſtroy him for. The beſt ſort of caſtor is what comes from Ruſſia. So much is Ruſſian caſtor ſuperior to the American, that two guineas per pound are paid for the former, and only 8s. 6d. for the latter. The Ruſſian caſtor is in large hard round cods, which appear, when cut, full of a brittle, red, liver coloured ſubſtance, interſperſed with membranes and fibres exquiſitely interwoven. An inferior ſort is brought from Dantzic, and is generally fat and moiſt. The American caſtor, which is the worſt of all, is in longiſh thin cods. Ruſſia caſtor has a ſtrong diſagreeable ſmell ; and an acrid, bitteriſh, and nauſeous taſte. Water extracts the nauſeous part, with little of the finer bitter ; rectified ſpirit extracts this laſt without much of the nauſeous ; proof ſpirit both : water elevates the whole of its flavour in diſtillation ; rectified ſpirit brings over nothing. Caſtor is looked upon as one of the capital nervine and antihyſteric medicines : ſome celebrated practitioners, nevertheleſs, have doubted its virtues ; and Neumann and Stahl declare it inſignificant. Experience, however, has ſhown that the virtues of caſtor are conſiderable, though leſs than they have been generally ſuppoſed.

CASTRATION, in *Surgery*, the operation of gelding, i. e. of cutting off the teſticles, and putting a male animal out of the capacity of generation.

Caſtration is in much uſe in Aſia, eſpecially among the Turks, who practiſe it on their ſlaves, to prevent any commerce with their women. The Turks often make a general amputation.

Caſtration alſo obtains in Italy, where it is uſed with a view to preſerve the voice for ſinging. See Eunuch.

The Perſians, and other eaſtern nations, have divers methods of making eunuchs, different from thoſe which obtain in Europe: we ſay, of making eunuchs, for it is not always done among them by cutting, or even colliſion. Cicuta and other poiſonous herbs do the ſame office, as is ſhown by Paulus Ægineta. Thoſe eunuchiſed in this manner are called *thlibiæ*. Beſides which there is another ſort called *thlaſiæ*, in whom the genitals are left entire, and only the veins which ſhould feed them are cut; by which means the parts do indeed remain, but ſo lax and weak, as to be of no uſe.

Caſtration was for ſome time the puniſhment of adultery. By the laws of the Viſigoths, Sodomites underwent the ſame puniſhment.

By the civil law it is made penal in phyſicians and ſurgeons to caſtrate, even with conſent of the party, who is himſelf included in the ſame penalty, and his effects forfeited. The offence of Mayhem by caſtration is, according to all our old writers, felony; though committed upon the higheſt provocation. See a record to this purpoſe of Henry III. tranſcribed by Sir Edward Coke, 3 Inſt. 62. or Blackſtone's Com. vol. iv. p. 206.

Caſtration is ſometimes found neceſſary on medicinal conſiderations, as in mortifications, and ſome other diſeaſes of the teſticles, eſpecially the *ſarcocele* and *varicocele*. Some have alſo uſed it in maniac caſes.

Castration is alſo in ſome ſort practiſed on women. Athenæus mentions that King Andramytes was the firſt who caſtrated women. Heſychius and Suidas ſay Gyges did the ſame thing. Galen obſerves, that women cannot be caſtrated without danger of life; and Dalechampius, on the fore-mentioned paſſage of Athenæus, holds, that it is only to be underſtood of ſimple padlocking.

Castration, in reſpect of brutes, is called Gelding and Spaying.

Castration alſo denotes the art of retrenching, or cutting away any part of a thing from its whole.—Caſtrating a book, among bookſellers, is the taking out ſome leaf, ſheet, or the like, which renders it imperfect and unfit for ſale. The term is alſo applied to the taking away particular paſſages, on account of their obſcenity, too great freedom with reſpect to government, &c.

Castration, among botaniſts, a term derived from the fancied analogy betwixt plants and animals. The caſtration of plants conſiſts in cutting off the *antheræ*, or tops of the ſtamina, before they have attained maturity, and diſperſed the pollen or fine duſt contained within their ſubſtance. This operation has been frequently practiſed by the moderns, with a view to eſtabliſh or confute the doctrine of the ſexes of plants; the antheræ or tops being conſidered by the ſexualiſts as the male organs of generation. The experiment of caſtration ſucceeds principally on plants which, like the melon, have their male flowers detached from the female. In ſuch as have both male and female flowers contained within the ſame covers, this operation cannot be eaſily performed without endangering the neighbouring organs. The reſult of experiments on this ſubject by Linnæus, Alſton, and other eminent botaniſts, may be ſeen under the article Botany.

CASTREL, a kind of hawk reſembling the lanner in ſhape, but the hobby in ſize. The caſtrel is alſo called keſtrel, and is of a ſlow and cowardly kind; her game is the grouſe, though ſhe will kill a partridge.

CASTRES, a city of Languedoc, in France, about 35 miles eaſt of Thoulouſe. E. Long. 2°. N. Lat. 34. 40. It is a biſhop's ſee.

CASTRO, the capital of the iſland of Chiloe, on the coaſt of Chili in South America. W. Long. 82. S. Lat. 43.

Castro is alſo the capital of a duchy of the ſame name in the pope's territories in Italy, ſituated on the confines of Tuſcany. E. Long. 12. 35. N. Lat. 42. 30.

Castro, *Pietro de*, a celebrated painter, who flouriſhed about the middle of the 17th century. The ſubjects which this great artiſt choſe to paint, were what are diſtinguiſhed by the name of ſtill life; vaſes, ſhells, muſical inſtruments, gems, veſſels of gold, ſilver, and cryſtal, books, and rich bracelets: and in thoſe ſubjects his choice and diſpoſition were elegant, and his execution admirable.

CASTRUCCIO, Castracani, a celebrated Italian general, was born (nobody knows of whom) at Lucca in Tuſcany in 1284, and left in a vineyard covered with leaves, where he was found by Dianora a widow lady, the ſiſter of Antonio, a canon of St Michael in Lucca, who was deſcended from the illuſtrious family of the Caſtracani. The lady having no children, ſhe reſolved to bring him up, and educated him as carefully as he had been her own. She intended him for a prieſt; but he was ſcarcely 14 years old when he began to devote himſelf to military ſports, and thoſe violent exerciſes which ſuited his great ſtrength of body. The factions named the *Guelfs* and *Gibelines* then ſhared all Italy between them; divided the popes and the emperors; and engaged in their different intereſts not only the members of the ſame town, but even thoſe of the ſame family. Franciſco, a conſiderable perſon on the ſide of the Gibelines, obſerving Caſtruccio's uncommon ſpirit and great qualities, prevailed with Antonio to let him turn ſoldier; on which Caſtruccio ſoon became acquainted with every thing belonging to that profeſſion, and was made a lieutenant of a company of foot by Franciſco Guinigi. In his firſt campaign he gave ſuch proofs of his courage and conduct as ſpread his fame all over Lombardy; and Guinigi, dying ſoon after, committed to him the care of his ſon and the management of his eſtate. Still diſtinguiſhing himſelf by his exploits, he filled his commander in chief with ſuch jealouſy and envy, that he was impriſoned by ſtratagem in order to be put to death. But the people of Lucca ſoon releaſed him, and afterwards choſe him for their ſovereign prince.—The Gibelines conſidered him as the chief of their party; and thoſe who had been baniſhed from their country fled to him for protection, and unanimouſly promiſed, that if he could reſtore them to their eſtates, they would ſerve him ſo effectually that the ſovereignty of their country ſhould be his reward. Flattered by theſe promiſes, he entered into a league with the prince of Milan. He kept his army conſtantly on foot, employing it as beſt ſuited his own deſigns. For ſervices he had done the pope, he was made ſenator of Rome with more than ordinary ceremony; but while there, received news which obliged him to haſten back to Lucca. The Florentines entered into a war with him, but Caſtruccio fought his way through them; and the ſupreme authority of Tuſcany was ready to fall into his hands, when a period was put to his life. In May 1328, he gained a complete victory over his enemies, who amounted to 30,000 foot and 10,000 horſe; in which 22,000 of them were ſlain, with the loſs of not quite 1600 of his own men; but as he was returning from the field of battle, tired with the action, and covered with ſweat, he halted a little, in order to thank and careſs his ſoldiers as they paſſed; when, the north wind blowing upon him, he was immediately ſeized with an ague, which he at firſt neglected, but it carried him off in a few days, in the 44th year of his age.

Machiavel, who has written the life of Caſtruccio, ſays, that he was not only an extraordinary man in his own age, but he would have been ſo in any other. He was of a noble aſpect, and of the moſt winning addreſs. He had all the qualities that make a man great; was grateful to his friends, juſt to his ſubjects, terrible to his enemies. No man was more forward to encounter dangers; no man more careful to eſcape them. He had an uncommon preſence of mind, and often made repartees with great ſmartneſs. Some of them are recorded, which diſcover a ſingular turn of humour; and, for a ſpecimen, we ſhall mention three or four of them.—Paſſing one day through a ſtreet where there was a houſe of bad fame, he ſurpriſed a young man, who was juſt coming out, and who, upon ſeeing him, was all over bluſhes and confuſion: "Friend, you ſhould not be aſhamed when you come out, but when you go in."—One aſking a favour of him with a thouſand impertinent and ſuperfluous words: "Hark you, friend; when you would have any thing with me for the future, ſend another man to aſk it."—Another great talker having tired him with a tedious diſcourſe, excuſed himſelf at laſt, by ſaying, he was afraid he had been troubleſome. "No indeed, (replied he), for I did not mind one word you ſaid.—He was forced to put a citizen of Lucca to death, who had formerly been a great inſtrument of his advancement; and being reproached by ſomebody for having dealt ſo ſeverely with an old friend, replied, "No, you are miſtaken, it was with a new foe."—One of his courtiers, deſirous to regale him, made a ball and invited him to it. Caſtruccio came, entertained himſelf among the ladies, danced, and did other things, which did not ſeem to comport with the dignity of his rank. One of his friends intimating that ſuch freedoms might diminiſh the reverence that ought to be paid him; "I thank you for your caution; but he who is reckoned wiſe all the day, will never be reckoned a fool at night."

CASTRUM DOLORIS, in middle age writers, denotes a catafalco, or a lofty tomb of ſtate, erected in honour of ſome perſons of eminence, uſually in the church where his body is interred; and decorated with arms, emblems, lights, and the like.

Eccleſiaſtical writers ſpeak of a ceremony of conſecrating a *caſtrum doloris*; the edifice was to be made to repreſent the body of the deceaſed, and the prieſt and deacon were to take their poſts, and ſay the prayers after the ſame manner as if the corpſe were actually preſent.

CASTS. See CASTING.

CASU CONSIMILI, in *Law*, a writ of entry granted where a tenant, by courteſy or for life, aliens either in fee, in tail, or for the term of another's life. It is brought by him in reverſion againſt the perſon to whom ſuch tenant does ſo alien to the prejudice of the reverſioner in the tenant's lifetime.

Casu Proviſo, in *Law*, a writ of entry founded on the ſtatute of Glouceſter, where a tenant in dower aliens the lands ſhe ſo holds in fee or for life; and lies for the party in reverſion againſt the alliance.

CASUAL, ſomething that happens fortuitouſly, without any deſign, or any meaſures taken to bring it to paſs.

Casual Revenues, are thoſe which ariſe from forfeitures, confiſcations, deaths, attainders, &c.

Casual Theology, a denomination given to what is more frequently called CASUISTRY.

CASUALTY, in a general ſenſe, denotes an accident, or a thing happening by chance, not deſign. It is particularly uſed for an accident producing unnatural death.

CASUALTY, in *Scots Law*. *Caſualties of a ſuperior*, are thoſe duties and emoluments which a ſuperior has right to demand out of his vaſſal's eſtate, over and beſides the conſtant yearly duties eſtabliſhed by the *reddendo* of his charter upon certain caſual events.

CASUALTY, in *Metallurgy*. See CAUSALTY.

CASUIST, a perſon who propoſes to reſolve caſes of conſcience. Eſcobar has made a collection of the opinions of all the caſuiſts before him. M. le Feore, preceptor of Louis XIII. called the books of the caſuiſts the art of quibbling with God: which does not ſeem far from truth, by reaſon of the multitude of diſtinctions and ſubtleties they abound withal. Mayer has publiſhed a bibliotheca of caſuiſts, containing an account of all the writers on caſes of conſcience, ranged under three heads; the firſt comprehending the Lutheran, the ſecond the Calviniſt, and the third the Romiſh caſuiſts.

CASUISTRY, the doctrine and ſcience of conſcience and its caſes, with the rules and principles of reſolving the ſame; drawn partly from natural reaſon or equity; partly from authority of Scripture, the canon law, councils, fathers, &c. To caſuiſtry belongs the deciſion of all difficulties ariſing about what a man may lawfully do or not do; what is ſin or not ſin; what things a man is obliged to do in order to diſcharge his duty, and what he may let alone without breach of it.

CASUS AMISSIONIS, in *Scots Law*. In actions proving the tenor of obligations inextinguiſhable by the debtor's retiring or cancelling them, it is neceſſary for the purſuer, before he is allowed a proof of the tenor, to condeſcend upon ſuch a *caſus amiſſionis*, or accident by which the writing was deſtroyed, as ſhows it was loſt while in the writer's poſſeſſion.

CAT, in *Zoology*. See Felis, Mammalia *Index*.

Cat, in ſea affairs, a ſhip employed in the coal trade, formed from the Norwegian model. It is diſtinguiſhed by a narrow ſtern, projecting quarters, a deep *waiſte*, and by having ornamental figures on the prow. Theſe veſſels are generally built remarkably ſtrong, and carry from four to ſix hundred tons, or, in the language of their own mariners, from 20 to 30 *keels* of coals.

Cat, is alſo a ſort of ſtrong tackle, or combination of pulleys, to hook and draw the anchor perpendicularly up to the *cat-head*. See *Cat-Heads*.

Cat's-Eye, or *Sun ſtone* of the Turks, a kind of gem found chiefly in Siberia. Cat's eye is by the Latins called *oculus cati*, and ſometimes *onycopalus*, as having white zones or rings like the onyx, and its colours variable like opal, from which laſt it differs chiefly by its ſuperior hardneſs. It is very hard, and ſemitranſparent, and has different points, from whence the light is reflected with a kind of yellowiſh radiation ſomewhat ſimilar to the eyes of cats, from whence it had its name. The beſt of them are very ſcarce, and jewellers cut them round to the greateſt advantage. One of theſe ſtones, an inch in diameter, was in the poſſeſſion of the Duke of Tuſcany.

Cat-fiſh, in *Ichthyology*. See Squalus, Ichthyology *Index*.

Cat-Gut, a denomination given to ſmall ſtrings for fiddles, and other inſtruments, made of the inteſtines of ſheep or lambs, dried and twiſted together, either ſingly, or ſeveral together. Theſe are ſometimes coloured red, ſometimes blue, but are commonly left whitiſh or browniſh, the natural colour of the gut. They are alſo uſed by watchmakers, cutlers, turners, and other artificers. Great quantities are imported into England, and other northern countries, from Lyons and Italy.

Cat Harpings, a purchaſe of ropes employed to brace in the ſhrouds of the lower maſts behind their yards, for the double purpoſe of making the ſhrouds more tight, and of affording room to draw in the yards more obliquely, to *trim* the ſails for a ſide-wind, when they are ſaid to be cloſe-hauled.

Cat-Heads, two ſtrong ſhort beams of timber, which project almoſt horizontally over the ſhip's bows on each ſide of the bowſprit; being like two radii which extend from a centre taken in the direction of the bowſprit. That part of the cat-head which reſts upon the forecaſtle, is ſecurely bolted to the beams: the other part projects like a crane, as above deſcribed, and carries in its extremity two or three ſmall wheels or *ſheaves* of braſs or ſtrong wood, about which a rope called the *cat-fall*, paſſes and communicates with the cat-block, which alſo contains three ſheaves. The machine formed by this combination of pulleys is called the *Cat*, which ſerves to pull the anchor up to the cat-head, without tearing the ſhip's ſides with its flukes. The cat-head alſo ſerves to ſuſpend the anchor clear of the bow, when it is neceſſary to let it go: it is ſupported by a ſort of knee, which is generally ornamented with ſculpture. See Plate CXXXVI.

The cat-block is filled with a large and ſtrong hood, which catches the ring of the anchor when it is to be drawn up.

Cat-Mint. See Mentha, Botany *Index*.

Cat-Salt, a name given by our ſalt-workers to a very beautifully granulated kind of common ſalt. It is formed out of the bittern, or leach brine, which runs from the ſalt when taken out of the pan. When they draw out the common ſalt from the boiling pans, they put it into long wooden troughs, with holes bored at the bottom for the brine to drain out; under theſe troughs are placed veſſels to receive this brine, and acroſs them ſmall ſticks to which the cat ſalt affixes itſelf in very large and beautiful cryſtals. This ſalt contains ſome portion of the bitter purging ſalt, is very ſharp and pungent, and is white when powdered, though pellucid in the maſs. It is uſed by ſome for the table, but the greateſt part of what is made of it is uſed by the makers of hard ſoap.

Cat-Silver. See Mica.

CATACAUSTIC curves, in the higher geometry, that ſpecies of cauſtic curves which are formed by reflection. See Fluxions.

CATACHRESIS, in *Rhetoric*, a trope which borrows the name of one thing to expreſs another. Thus Milton, deſcribing Raphael's deſcent from the empyreal heaven to paradiſe, ſays,

> "Down thither prone in flight,
> "He ſpeeds, and through the vaſt ethereal ſky
> "Sails between worlds and worlds."

CATACOMB, a grotto, or ſubterraneous place for the burial of the dead.

Some derive the word *catacomb* from the place where ſhips are laid up, which the modern Latins and Greeks called *cumbæ*. Others ſay, that *cata* was uſed for *ad*, and *catacumbas* for *adtumbas*: accordingly, Dadin ſays, they anciently wrote *catatumbas*. Others fetch the word from the Greek, κατα, and κυμβος, a hollow, cavity, or the like.

Anciently the word *catacomb* was only underſtood of the tombs of St Peter and St Paul; and M. Chatelain obſerves, that, among the more knowing of the people of Rome, the word *catacomb* is never applied to the ſubterraneous burying-places hereafter mentioned, but only to a chapel in St Sebaſtian, one of the ſeven ſtational churches; where the ancient Roman kalendars ſay the body of St Peter was depoſited, under the conſulate of Tuſcus and Baſſus, in 258.

Catacombs of Italy; a vaſt aſſemblage of ſubterraneous ſepulchres about Rome, chiefly at about three miles from that city, in the Via Appia; ſuppoſed to be the ſepulchre of the martyrs: and which are viſited accordingly out of devotion, and relicks thence taken and diſperſed throughout the catholic countries, after having been firſt baptized by the pope under the name of ſome ſaint. Theſe *catacombs* are ſaid by many to be caves or cells wherein the primitive Chriſtians hid and aſſembled themſelves together, and where they interred ſuch among them as were martyred. Each *catacomb* is three feet broad, and eight or ten high; running in form of an alley or gallery, and communicating with others: in many places they extend within a league of Rome. There is no maſonry or vaulting therein, but each ſupports itſelf: the two ſides, which we may look on as the *parietes* or walls, were the places where the dead were depoſited ; which were laid lengthwiſe, three or four rows over one another, in the ſame *catacomb*, parallel to the alley. They were commonly cloſed with large thick tyles, and ſometimes pieces of marble, cemented in a manner inimitable by the moderns. Sometimes, though very rarely, the name of the deceaſed is found on the tyle : frequently a palm is ſeen, painted or engraven, or the cypher Xp, which is commonly read *pro Chriſto*. The opinion held by many Proteſtant authors is, that the *catacombs* are heathen ſepulchres, and the ſame with the puticuli mentioned by Feſtus Pompeius ; maintaining, that whereas it was the practice of the ancient Romans to burn their dead, the cuſtom was, to avoid expence, to throw the bodies of their ſlaves to rot in holes of the ground ; and that the Roman Chriſtians, obſerving at length the great veneration paid to relicks, reſolved to have a ſtock of their own : entering therefore the *catacombs*, they added what cyphers and inſcriptions they pleaſed ; and then ſhut them up again, to be opened on a favourable occaſion. Thoſe in the ſecret, add they, dying or removing, the contrivance was forgot, till chance opened them at laſt. But this opinion has even leſs of probability than the former. Mr Monro, in the *Philoſophical Tranſactions*, ſuppoſes the *catacombs* to have been originally the common ſepulchres of the firſt Romans, and dug in conſequence of theſe two opinions, viz. that ſhades hate the light ; and that they love to hover about the places where the bodies are laid.

Though the catacombs of Rome have made the greateſt noiſe of any in the world, there are ſuch belonging to many other cities. Thoſe of Naples, according to Biſhop Burnet, are much more noble and ſpacious than the catacombs of Rome. Catacombs have alſo been diſcovered at Syracuſe and Catanea in Sicily, and in the iſland of Malta. The Roman catacombs take particular names from the churches in their neighbourhood, and ſeem to divide the circumference of the city without the walls between them, extending their galleries everywhere under, and a vaſt way from it ; ſo that all the ground under Rome, and for many miles about it, ſome ſay 20, is hollow. The largeſt, and thoſe commonly ſhown to ſtrangers, are the catacombs of San Sebaſtiano, thoſe of Saint Agneſe, and the others in the fields a little off Saint Agneſe. Women are only allowed to go into the catacombs in the churchyard of the Vatican on Whitſun Monday, under pain of excommunication. There are men kept conſtantly at work in the catacombs. As ſoon as theſe labourers diſcover a grave with any of the ſuppoſed marks of a ſaint upon it, intimation is given to the cardinal camerlingo, who immediately ſends men of reputation to the place, where finding the palm, the monogram, the coloured glaſs, &c. the remains of the body are taken up with great reſpect, and tranſlated to Rome. After the labourers have examined a gallery, they ſtop up the entry that leads to it ; ſo that moſt of them remain thus cloſed up ; only a few being left open to keep up the trade of ſhowing them to ſtrangers. This, they ſay, is done to prevent people from loſing themſelves in theſe ſubterraneous labyrinths, which indeed has often happened ; but more probably to deprive the public of the means of knowing whither and how far the catacombs are carried.

The method of preſerving the dead in catacombs ſeems to have been common to a number of the ancient nations. The catacombs of Egypt are ſtill extant about nine leagues from the city of Grand Cairo, and two miles from the city of Zaccara. They extend from thence to the pyramids of Pharaoh, which are about eight miles diſtant. They lie in a field covered with a fine running ſand, of a yellowiſh colour. The country is dry and hilly ; the entrance of the tombs is choked up with ſand ; there are many open, but more that are ſtill concealed.

The bodies found in catacombs, eſpecially thoſe of Egypt, are called *mummies* ; and as their fleſh was formerly reckoned an efficacious medicine, they were much ſought after. In this work the labourers were often obliged to clear away the ſand for weeks together, without finding what they wanted. Upon coming to a little ſquare opening of about 18 feet in depth, they deſcend into it by holes for the feet placed at proper intervals ; and there they are ſure of finding a mummy. Theſe caves, or *wells* as they call them there, are hollowed out of a white free-ſtone, which is found in all this country a few feet below the covering of ſand. When one gets to the bottom of theſe, which are ſometimes 40 feet below the ſurface, there are ſeveral ſquare openings on each ſide into paſſages of 10 or 15 feet wide ; and theſe lead to chambers of 15 or 20 feet ſquare. Theſe are all hewn out in the rock ; and in each of the catacombs are to be found ſeveral of theſe apartments communicating with one another. They extend a great way under ground, ſo as to be under the city of Memphis, and in a manner to undermine its environs. In ſome of the chambers the walls are adorned with figures and hieroglyphics ; in others the mummies are found in tombs, round the apartment, hollowed out in the rock.

The Egyptians ſeem to have excelled in the art of embalming and preſerving their dead bodies ; as the mummies found in the Egyptian catacombs are in a better ſtate than the bodies found either in the Italian catacombs or thoſe of any other part of the world. See EMBALMING and MUMMY.

Laying up the bodies in caves, is certainly the original way of diſpoſing of the dead ; and appears to have been propagated by the Phœnicians throughout the countries to which they ſent colonies ; the interring as we now do in the open air or in temples was firſt introduced by the Chriſtians. When an ancient hero died, or was killed in a foreign expedition, as his body was liable to corruption, and for that reaſon unfit to be tranſported entire, they fell on the expedient of burning, in order to bring home the aſhes, to oblige the *manes* to follow ; that ſo his country might not be deſtitute of the benefit of his tutelage. It was thus burning ſeems to have had its original ; and by degrees it became common to all who could bear the expences of it, and took place of the ancient burying : thus *catacombs* became diſuſed among the Romans, after they had borrowed the manner of burning from the Greeks, and then none but ſlaves were laid in the ground. See BURIAL, &c.

CATALAUNI, called alſo *Durocatalauni*, a town of Gallia Belgica : *Catalauni*, the people. A name rather of the lower age than of claſſical antiquity. Now *Chalons ſur Marne*, in Champagne. E. Long. 4. 35. N. Lat. 48. 55.

CATADROMUS, from κατα and δρεμω, *I run*, in antiquity, a ſtretched ſloping rope in the theatres, down which the *funambuli* walked to ſhow their ſkill. Some have taken the word to ſignify the hippodrome or decurſorium, wherein the Roman knights uſed to exerciſe themſelves in running and fighting on horſeback. But the moſt natural meaning is that of a rope faſtened at one end to the top of the theatre, and at the other to the bottom, to walk or run down, which was the higheſt glory of the ancient *ſchænobates*, or *funambuli.* Elephants were alſo taught to run down the *catadromus.* Suetonius ſpeaks of the exploit of a Roman knight, who paſſed down the *catadromus* mounted on an elephant's back.

CATAGOGION, a heathen feſtival at Epheſus, celebrated on the 22d of January, in which the devotees run about the ſtreets, dreſſed in divers antic and unſeemly manners, with huge cudgels in their hands, and carrying with them the images of their gods; in which guiſe they raviſhed the women they met with, abuſed and often killed the men, and committed many other diſorders, to which the religion of the day gave a ſanction.

CATAGRAPHA, in antiquity, denote oblique figures or views of mens faces; anſwering to what the moderns call *profiles.*

Catagrapha are ſaid to be the invention of Simon Cleonæus, who firſt taught painters to vary the looks of their figures, and ſometimes direct them upwards, ſometimes downwards, and ſometimes ſidewards or backwards.

CATALEPSIS, or CATALEPSY, in *Medicine*, a kind of apoplexy, or a drowſy diſeaſe, wherein the patient is taken ſpeechleſs, ſenſeleſs, and fixed in the ſame poſture wherein the diſeaſe firſt ſeized him; his eyes open, without ſeeing or underſtanding. See MEDICINE *Index.*

CATALOGUE, a liſt or enumeration of the names of ſeveral books, men, or other things, diſpoſed according to a certain order.

Catalogues of books are digeſted in different manners, ſome according to the order of the times when the books were printed, as that of Mattaire; others according to their form and ſize, as the common bookſellers catalogues; others according to the alphabetical order of the authors names, as Hyde's catalogue of the Bodleian library; others according to the alphabetical order of matters or ſubjects, which are called *real or claſſical catalogues*, as thoſe of Lipenius and Draudius; laſtly, others are digeſted in a mixed method, partaking of ſeveral of the former, as De Seine's catalogue of Cardinal Sluſius's library, which is firſt divided according to the ſubjects or ſciences, and afterwards the books in each are recited alphabetically.

The moſt applauded of all catalogues is that of Thuanus's library, in which are united the advantages of all the reſt. It was firſt drawn up by the two Puteani in the alphabetical order, then digeſted according to the ſciences and ſubjects by Iſhm. Bullialdus, and publiſhed by F. Queſnel at Paris in 1679; and reprinted, though incorrectly, at Hamburgh, in 1704. The books are here ranged with juſtneſs under their ſeveral ſciences and ſubjects, regard being ſtill had to the nation, ſect, age, &c. of every writer. Add, that only the beſt and choiceſt books on every ſubject are found here, and the moſt valuable editions. Yet the catalogue of M. le Telliers archbiſhop of Rheims' library, made by M. Clement, is not inferior to any publiſhed in our age, either on account of the number and choice of the books, or the method of its diſpoſition. One advantage peculiar to this catalogue is, the multitude of anonymous and pſeudonymous authors detected in it, ſcarce to be met with elſewhere. Some even prefer it to Thuanus's catalogue, as containing a greater variety of claſſes and books on particular ſubjects.

The conditions required in a catalogue are, that it indicate at the ſame time the order of the authors and of the matters, the form of the book, the number of volumes, the chronological order of the editions, the language it is written in, and its place in the library; ſo as that all theſe circumſtances may appear at once in the ſhorteſt, cleareſt, and exacteſt manner poſſible. In this view all the catalogues yet made will be found to be defective.

An anonymous French writer has laid down a new plan of a catalogue, which ſhall unite all the advantages and avoid all the inconveniences of the reſt.

The Jeſuits of Antwerp have given us a catalogue of the popes; which makes what they call their *Propilæum.*

CATALOGUE *of the Stars*, is a liſt of the fixed ſtars, diſpoſed in their ſeveral conſtellations; with the longitudes, latitudes, &c. of each; or according to their right aſcenſions, that is, the order of their paſſing over the meridian.

The firſt who undertook to reduce the fixed ſtars into a catalogue was Hipparchus Rhodius, about 120 years before Chriſt; in which he made uſe of the obſervations of Timocharis and Ariſtyllus for about 180 years before him. Ptolemy retained Hipparchus's catalogue containing 1026 fixed ſtars; though he himſelf made abundance of obſervations, with a view to a new catalogue, A. D. 140. About the year of Chriſt 880, Albategni, a Syrian, brought down the ſame to his time. Anno 1437, Ulugh Beigh, king of Parthia and India, made a new catalogue of 1022 fixed ſtars, ſince tranſlated out of Perſian into Latin by Dr Hyde. The third who made a catalogue from his own obſervations was Tycho Brahe, who determined the places of 777 ſtars for the year 1600, which Kepler from other obſervations of Tycho afterwards increaſed to the number of 1000 in the Rudolphine tables; adding thoſe of Ptolemy omitted by Tycho, and of other authors; ſo that his catalogue amounts to above 1160. At the ſame time, William landgrave of Heſſe, with his mathematicians, Chriſtopher Rothmannus and Juſtus Byrgius, determined the places of 400 fixed ſtars by his own obſervations, with their places rectified for the year 1593; which Hevelius prefers to thoſe of Tycho's. Ricciolus, in his *Aſtronomia Reformata*, determined the places of 101 ſtars for the year 1700, from his own obſervations; for the reſt he followed Tycho's catalogue, altering it where he thought fit. Anno 1667, Dr Halley, in the iſland of St Helena, obſerved 350 ſouthern ſtars not viſible in our horizon. The ſame labour was repeated by F Noel in 1710, who publiſhed a new catalogue of the ſame ſtars conſtructed for the year 1687.

Bayer, in his *Uranometria*, publiſhed a catalogue of 1160 ſtars, compiled chiefly from Ptolemy and Tycho, in which every ſtar is marked with ſome letter of the Greek alphabet; the biggeſt ſtar in any conſtellation being denoted by the firſt letter, the next by the ſecond, &c. and if the number exceeds the Greek alphabet, the remaining ſtars are marked by letters of the Roman alphabet, which letters are preſerved by Flamſteed, and by Senex on his globes. The celebrated Hevelius compoſed a catalogue of 1888 ſtars, 1553 of which were obſerved by himſelf; and their places were computed for the year 1660.

The laſt and greateſt is the Britannic catalogue, compiled from the obſervations of the accurate Mr Flamſteed; who for a long ſeries of years devoted himſelf wholly thereto. As there was nothing wanting either in the obſerver or apparatus, we may look on this as a perfect work ſo far as it goes. It is to be regretted the impreſſion had not paſſed through his own hands: that now extant was publiſhed by authority, but without the author's conſent: it contains 2734 ſtars. There was another publiſhed in 1725, purſuant to his teſtament; containing no leſs than 3000 ſtars, with their places rectified for the year 1689: to which is added Mr Sharp's catalogue of the ſouthern ſtars not viſible in our hemiſphere, adapted to the year 1726.

The firſt catalogue, we believe, that was printed in the new or ſecond form, according to the order of the right aſcenſions, is that of De la Caille, given in his Ephemerides for the ten years between 1755 and 1765, and printed in 1755. It contains the right aſcenſions and declinations of 307 ſtars, adapted to the beginning of the year 1750. In 1757 De la Caille publiſhed his *Aſtronomiæ Fundamenta*, containing a catalogue of the right aſcenſions and declinations of 398 ſtars, likewiſe adapted to the beginning of 1750. And in 1763, the year after his death, was publiſhed the *Cœlum Auſtrale Stelliferum* of the ſame author; containing a catalogue of the places of 1942 ſtars, all ſituated to the ſouthward of the tropic of Capricorn, and obſerved by him while he was at the Cape of Good Hope in 1751 and 1752; their places being alſo adapted to the beginning of 1750. In the ſame year was publiſhed his Ephemerides for the ten years between 1765 and 1775; in the introduction to which are given the places of 515 zodiacal ſtars, all deduced from the obſervations of the ſame author; the places adapted to the beginning of the year 1765.

In the Nautical Almanac for 1773, is given a catalogue of 387 ſtars, in right aſcenſion, declination, longitude and latitude, derived from the obſervations of the late celebrated Dr Bradley, and adjuſted to the beginning of the year 1760. This ſmall catalogue, and the reſults of about 1200 obſervations of the moon, are all that the public have yet ſeen of the multiplied labours of this moſt accurate and indefatigable obſerver, although he has now (1798) been dead upwards of 36 years.

In 1775 was publiſhed a thin volume, entitled, *Opera Inedita*, containing ſeveral papers of the late Tobias Mayer, and among them a catalogue of the right aſcenſions and declinations of 998 ſtars, which may be occulted by the moon and planets; the places being adapted to the beginning of the year 1756.

At the end of the firſt volume of "Aſtronomical Obſervations made at the Royal Obſervatory at Greenwich," publiſhed in 1776, Dr Maſkelyne, the preſent aſtronomer royal, has given a catalogue of the places of 34 principal ſtars, in right aſcenſion and north polar diſtance, adapted to the beginning of the year 1770.

Theſe, being the reſult of ſeveral years repeated obſervations, made with the utmoſt care, and the beſt inſtruments, it may be preſumed are exceedingly accurate.

In 1782, M. Bode of Berlin publiſhed a very extenſive catalogue of 5058 of the fixed ſtars, collected from the obſervations of Flamſteed, Bradley, Hevelius, Mayer, De la Caille, Meſſier, Monnier, D'Arquier, and other aſtronomers; all adapted to the beginning of the year 1780; and accompanied with a celeſtial atlas or ſet of maps of the conſtellations, engraved in a moſt delicate and beautiful manner.

To theſe may be added Dr Herſchel's catalogue of double ſtars, printed in the Phil Tranſ. for 1782 and 1783; Meſſier's nebulæ and cluſters of ſtars, publiſhed in the *Connoiſſance des Temps* for 1784; and Herſchel's catalogue of the ſame kind given in the Phil. Tranſ. for 1786.

In 1789 Mr Francis Wollaſton publiſhed "A Specimen of a General Aſtronomical Catalogue, in Zones of North-polar Diſtance, and adapted to January 1. 1790." Theſe ſtars are collected from all the catalogues before-mentioned, from that of Hevelius downwards. This work contains five diſtinct catalogues; viz. Dr Maſkelyne's new catalogue of 36 principal ſtars; a general catalogue of all the ſtars, in zones of north polar diſtance; an index to the general catalogue; a catalogue of all the ſtars in the order in which they paſs the meridian; and a catalogue of zodiacal ſtars, in longitude and latitude.

Finally, in 1792, Dr Zach publiſhed at Gotha, *Tabulæ Motuum Solis*; to which is annexed a new catalogue of the principal fixed ſtars, from his own obſervations made in the years 1787, 1788, 1789, 1790. This catalogue contains the right aſcenſions and declinations of 381 principal ſtars, adapted to the beginning of the year 1800. *Hutton's Math. Dict.*

Beſides theſe two methods of forming *catalogues* of the ſtars, Dr Herſchel has propoſed a new one, in which the comparative brightneſs of the ſtars is accurately expreſſed. It is long ſince aſtronomers were firſt led to arrange the ſtars in claſſes of different magnitudes by their various degrees of brilliancy or luſtre. Brightneſs and ſize have at all times been conſidered as ſynonymous terms; ſo that the brighteſt ſtars have been referred to the claſs comprehending thoſe of the firſt magnitude; and as the ſubſequent orders of ſtars have been ſuppoſed to decreaſe in luſtre, their magnitude has been determined in the ſame decreaſing progreſſion; but the want of ſome fixed and ſatisfactory ſtandard of luſtre has been the ſource of conſiderable confuſion and uncertainty in ſettling the relative magnitudes of the ſtars. A ſtar marked 1.2m. is ſuppoſed to be between the firſt and ſecond magnitude; but 2.1m. intimates, that the ſtar is nearly of the ſecond magnitude, Catalogue of the Stars.

magnitude, and that it partakes ſomewhat of the luſtre of a ſtar of the firſt order. Such ſubdiviſions may be of ſome uſe in aſcertaining ſtars of the firſt, ſecond, and third claſſes; but the expreſſions 5m. 5.6m. 6.5m. 6m. muſt be very vague and indefinite. Dr Herſchel obſerves that he has found them ſo in fact; and he therefore conſiders this method of pointing out the different luſtre of ſtars as a reference to an imaginary ſtandard. If any dependence could be placed on this method of magnitudes, "it would follow, that no leſs than 11 ſtars in the conſtellation of the Lion, namely β, σ, π, ξ, A, *b*, *c*, *d*, 54, 48, 72, had all undergone a change in their luſtre ſince Flamſteed's time: For if the idea of magnitudes had been a clear one, our author, who marked β 1.2m. and γ 2m. ought to be underſtood to mean that β is larger than γ; but we now find that actually γ is larger than β. Every one of the eleven ſtars (ſays Dr Herſchel) which I have pointed out may be reduced to the ſame coutradiction."

The author has pointed oot the inſtances of the inſufficiency of this method, and of the uncertain concluſions that are deduced from it, in determining the comparative brightneſs of ſtars found not only in Mr Flamſteed's catalogue, but alſo in the catalogues of other aſtronomers. It is ſufficiently apparent that the preſent method of expreſſing the brightneſs of the ſtars is very defective. Dr Herſchel therefore propoſes a different mode, that is more preciſe and ſatisfactory.

"I place each ſtar (he ſays), inſtead of giving its magnitude, into a ſhort ſeries, conſtructed upon the order of brightneſs of the neareſt proper ſtars. For inſtance, to expreſs the luſtre of D, I ſay CDE. By this ſhort notation, inſtead of referring the ſtar D to an imaginary uncertain ſtandard, I refer it to a preciſe and determined exiſting one. C is a ſtar that has a greater luſtre than D, and E is another of leſs brightneſs than D. Both C and E are neighbouring ſtars, choſen in ſuch a manner that I may ſee them at the ſame time with D, and therefore may be able to compare them properly. The luſtre of C is in the ſame manner aſcertained by BCD; that of B by ABC; and alſo the brightneſs of E by DEF; and that of F by EFG.

"That this is the moſt natural, as well as the moſt effectual way to expreſs the brightneſs of a ſtar, and by that means to detect any change that may happen in its luſtre, will appear, when we conſider what is requiſite to aſcertain ſuch a change. We can certainly not wiſh for a more deciſive evidence, than to be aſſured, by actual inſpection, that a certain ſtar is now no longer more or leſs bright than ſuch other ſtars to which it has been formerly compared; provided we are at the ſame time aſſured that thoſe other ſtars remain ſtill in ther former unaltered luſtre. But if the ſtar D will no longer ſtand in its former order CDE, it muſt have undergone a change; and if that order is now to be expreſſed by CED, the ſtar has loſt ſome part of its luſtre; if, on the contrary, it ought now to be denoted by DCE, its brightneſs muſt have had ſome addition. Then, if we ſhould doubt the ſtability of C and E, we have recourſe to the orders BCD and DEF, which expreſs their luſtre; or even to ABC and EFG, which continue the ſeries both ways. Now having before us the ſeries BCDEF, or if neceſſary even the more extended one ABCDEFG, it will be impoſſible

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to miſtake a change of brightneſs in D, when every member of the ſeries is found in its proper order except D."

In the author's journal or catalogue, in which the order of the luſtre of the ſtars is fixed, each ſtar bears its own proper name or nomber, *e. g.* "the brightneſs of the ſtar δ Leonis may be expreſſed by β δ ε Leonis, or better by 94—68—17 Leonis; theſe being the numbers which the three above ſtars bear in the Britiſh catalogue of fixed ſtars."

This method of arrangement occurred to Dr Herſchel ſo early as the year 1782; but he was diverted from the regular purſuit of it by a variety of other aſtronomical engagements. After many trials, he propoſed, in the Tranſactions of the Royal Society of London for 1796, the plan which appeared to him the moſt eligible. It is as follows:—Inſtead of denoting particular ſtars by letters, he makes uſe of numbers; and in his choice of the ſtars which are to expreſs the luſtre of any particular one, he directs his firſt view to perfect equality. When two ſtars ſeem to be ſimilar both in brightneſs and magnitude, he puts down their numbers together, ſeparated merely by a point, as 30.24 Leonis; but if two ſtars, which at firſt ſeemed alike in their luſtre, appeared on a longer inſpection to be different, and the preference ſhould be always decidedly in favour of the ſame ſtar, he ſeparates theſe ſtars by a comma, thus, 41,94 Leonis. This order muſt not be varied; nor can three ſuch ſtars, as 20, 40, 39, Libræ, admit of a different arrangement. If the ſtate of the heavens ſhould be ſuch as to require a different order in theſe numbers, we may certainly infer that a change has taken place in the luſtre of one or more of them. When two ſtars differ very little in brightneſs, but ſo that the preference of the one to the other is indiſputable, the numbers that expreſs them are ſeparated by a ſhort line, as —17—70 Leonis, or 68—17—70 Leonis. When two ſtars differ ſo much in brightneſs, that one or two other ſtars might be interpoſed between them, and ſtill leave ſufficient room for diſtinction, they are diſtinguiſhed by a line and comma, thus, —, or by two lines, as 32— —41 Leonis. A greater difference than this is denoted by a broken line, thus, ———29 Bootis. On the whole, the author obſerves the marks and diſtinctions which he has adopted cannot poſſibly be miſtaken; "a point denoting equality of luſtre; a comma indicating the leaſt perceptible difference; a ſhort line to mark a decided but ſmall ſuperiority; a line and comma, or double line, to expreſs a conſiderable and ſtriking exceſs of brightneſs; and a broken line to mark any other ſuperiority which is to be looked upon as of no uſe in eſtimations that are intended for the purpoſe of directing changes."

The difficulties that attend this arrangement are not diſguiſed; but the importance and utility of it more than compenſate for the labour which it muſt neceſſarily require. By a method of this kind, many diſcoveries of changeable and periodical ſtars might probably have been made, which have eſcaped the moſt diligent and accurate obſervers. We might then, as the author ſuggeſts, be enabled to reſolve a problem in which we are all immediately concerned.

"Who, for inſtance, would not wiſh to know what degree of permanency we ought to aſcribe to the luſtre of our ſun? Not only the ſtability of our climates, but the

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the very exiſtence of the whole animal and vegetable creation itſelf, is involved in the queſtion. Where can we hope to receive information upon this ſubject but from aſtronomical obſervations? If it be allowed to admit the ſimilarity of ſtars with our ſun as a point eſtabliſhed, how neceſſary will it be to take notice of the fate of our neighbouring *ſuns*, in order to gueſs at that of our own! That *ſtar*, which among the multitude we have dignified by the name of *ſun*, to-morrow may ſlowly begin to undergo a gradual decay of brightneſs, like β Leonis, α Ceti, α Draconis, δ Urſæ majoris, and many other diminiſhing ſtars that will be mentioned in my catalogues. It may ſuddenly increaſe, like the wonderful ſtar in the back of Caſſiopeia's chair, and the no leſs remarkable one in the foot of Serpentarius; or gradually come on, like β Geminorum, β Ceti, ζ Sagittarii, and many other increaſing ſtars, for which I alſo refer to my catalogues; and, laſtly, it may turn into a periodical one of 25 days duration, as Algol is one of three days, δ Cephei of five, β Lyræ of ſix, η Antinoi of ſeven days, and as many others as are of various periods."

Having thus explained the general principle on which this catalogue is formed, as we find it in the author's firſt memoir on the ſubject, we muſt refer the reader to the doctor's own account for its particular arrangement, obſerving only that the catalogue ſubjoined comprehends nine conſtellations, which are arranged in alphabetical order, with the comparative brightneſs of the ſtars accurately ſtated. In a ſubſequent paper, publiſhed in the ſame volume, he has completely verified the utility of his method by experience, and ſhewn that there is no permanent change of luſtre in the ſtars. In the notes to his firſt catalogue he mentioned α Herculis as a periodical ſtar. By a ſeries of obſervations on this ſtar, compared with κ Ophiuchi, which was moſt conveniently ſituated for his purpoſe, he has been able not only to confirm this opinion, but to aſcertain its period. His obſervations are arranged in a table, by means of which he determines that this ſtar had gone through four ſucceſſive changes in an interval of 241 days; and therefore the duration of its period muſt be about 60 days and a quarter. This fact concurs with other circumſtances in evincing the rotatory motion of the ſtars on their axes. "Dark ſpots, or large portions of the ſurface leſs luminous than the reſt, turned alternately in certain directions, either towards or from us, will account for the phenomena of periodical changes in the luſtre of the ſtars, ſo ſatisfactorily, that we certainly need not look out for any other cauſe." If it be alleged that the periods in the change of luſtre of ſome ſtars, ſuch as Algol, β Lyræ, δ Cephei, and η Antinoi, are ſhort, being only 3, 5, 6, and 7 days reſpectively; while thoſe of ο Ceti, and of the changeable ſtar in Hydra, and that in the neck of the Swan, are long, amounting to 331, 394, and 497 days; and that we cannot aſcribe phenomena ſo different in their duration to the ſame cauſe—it may be anſwered to this objection, that the force of it is founded on our limited acquaintance with the ſtate of the heavens. To the ſeven ſtars, the periodical changes of which were before known, we may now add α Herculis, which performs a revolution of its changes in 60 days.

"The ſtep from the rotation of α Herculis to that of ο Ceti is far leſs conſiderable than that from the period of Algol to the rotation of α Herculis; and thus a link in the chain is now ſupplied, which removes the objection that aroſe from the vacancy." The rotation of the fifth ſatellite of Saturn is proved by the change obſervable in its light; and "this variation of light, owing to the alternate expoſition of a more or leſs bright hemiſphere of this periodical ſatellite, plainly indicates, that the ſimilar phenomenon of a changeable ſtar ariſes from the various luſtre of the different parts of its ſurface, ſucceſſively turned to us by its rotatory motion."

Catalonia || Catana.

Beſides, we perceive a greater ſimilarity between the ſun and the ſtars, by means of the ſpots that muſt be admitted to exiſt on their ſurfaces, as well as on that of the ſun.

Dr Herſchel farther obſerves, that the ſtars, beſides a rotatory motion on their axes, may have other movements; "ſuch as nutations or changes in the inclination of their axes; which, added to bodies much flattened by quick rotatory motions, or ſurrounded by rings like Saturn, will eaſily account for many new phenomena that then offer themſelves to our extended views."

CATALONIA, a province of Spain, bounded on the north by the Pyrenean mountains, which divide it from France; by the kingdom of Arragon and Valencia on the weſt; and by the Mediterranean ſea on the ſouth and eaſt. It is 155 miles in length, and 100 in breadth. It is watered by a great number of rivers; the principal of which are the Lobregat, the Ter, and the Segra. The air is temperate and healthy; but the land is mountainous, except in a few places. It produces, however, corn, wine, oil, pulſe, flax, and hemp, ſufficient for the inhabitants. The mountains are covered with large foreſts of tall trees, ſuch as the oak, the ever green oak, the beech, the pine, the fir, the cheſnut, and many others; with cork trees, ſhrubs, and medicinal plants. There are ſeveral quarries of marble of all colours, cryſtal, alabaſter, amethyſts, and lapis lazuli. Gold duſt has been found among the ſands of one or two of the rivers; and there are mines of tin, iron, lead, alum, vitriol, and ſalt. They likewiſe fiſh for coral on the eaſtern coaſt. The inhabitants are hardy, courageous, active, vigorous, and good ſoldiers, but apt to be diſcontented. The miquelets are a ſort of ſoldiers which guard the paſſes over the mountains, and ought to protect travellers; but if they are not paid to their minds, they ſeldom fail to pay themſelves. The river Lobregat divides Catalonia into two parts, the eaſt and weſt, according to their ſituation. This province comprehends 17 vigueries or territories; two of which are in Rouſillon, and belong to the French. The reſt are ſubject to the Spaniards. The principal towns are Barcelona the capital, Tarragona, Tortoſa, Lerida, Solſonia, Cardona Vich, Girona, Seu d'Urgel, Pui Cerda, and Cervera. Catalonia was the laſt province in Spain which ſubmitted to Philip in the Succeſſion war.

CATAMENIA, in *Medicine*. See MENSES.

CATAMITE, a boy kept for Sodomitical practices.

CATANA, or CATINA, in *Ancient Geography*, a town of Sicily, ſituated oppoſite to Ætna, to the ſouth-eaſt; one of the five Roman colonies: anciently built by the people of Naxus ſeven years after the building of Syracuſe, 728 years before Chriſt. It was the country of Charondas the famous lawgiver. The town is ſtill called *Catanea*. See CATANEA.

CATANANCHE, CANDIA LIONS FOOT. See BOTANY *Index*.

CATANEA, or CATANIA, a city of Sicily, ſeated on a gulf of the ſame name, near the foot of Mount Ætna, or Gibel. It was founded by the Chalcidians ſoon after the ſettlement of Syracuſe, and enjoyed great tranquillity till Hiero I. expelled the whole body of citizens; and after repleniſhing the town with a new ſtock of inhabitants, gave it the name of *Ætna*: immediately after his deceaſe, it regained its ancient name, and its citizens returned to their abodes. Catania fell into the hands of the Romans, among their earlieſt acquiſitions in Sicily, and became the reſidence of a prætor. To make it worthy of ſuch an honour, it was adorned with ſumptuous buildings of all kinds, and every convenience was procured to ſupply the natural and artificial wants of life. It was deſtroyed by Pompey's ſon, but reſtored with ſuperior magnificence by Auguſtus. The reign of Decius is famous in the hiſtory of this city, for the martyrdom of its patroneſs St Agatha. On every emergency her interceſſion is implored. She is piouſly believed to have preſerved Catanea from being overwhelmed by torrents of lava, or ſhaken to pieces by earthquakes; yet its ancient edifices are covered by repeated ſtreams of volcanic matter; and almoſt every houſe, even her own church, has been thrown to the ground. In the reign of William the Good, 20,000 Catanians, with their paſtor at their head, were deſtroyed before the ſacred veil could be properly placed to check the flames. In the laſt century the eruptions and earthquakes raged with redoubled violence, and Catania was twice demoliſhed. See ÆTNA.

The preſent prince of Biſcari has been at infinite pains, and ſpent a large ſum of money, in working down to the ancient town, which, on account of the numerous torrents of lava that have flowed out of Mount Ætna for theſe laſt thouſand years, is now to be ſought for in dark caverns many feet below the preſent ſurface of the earth. Mr Swinburne informs us that he deſcended into baths, ſepulchres, an amphitheatre, and a theatre, all very much injured by the various cataſtrophes that have befallen them. They were erected upon old beds of lava, and even built with ſquare pieces of the ſame ſubſtance, which in no inſtance appears to have been fuſed by the contact of new lavas: The ſciarra, or ſtones of cold lava, have conſtantly proved as ſtrong a barrier againſt the flowing torrent of fire as any other ſtone could have been, though ſome authors were of opinion that the hot matter would melt the old maſs and incorporate with it.

This city has been frequently defended from the burning ſtreams by the ſolid maſs of its own ramparts, and by the air compreſſed between them and the lava; as appears by the torrent having ſtopt within a ſmall diſtance of the walls, and taken another direction. But when the walls were broken or low, the lava collected itſelf till it roſe to a great height, and then poured over in a curve. A ſimilar inſtance is ſeen at the Torre del Greco near Naples, where the ſtream of liquid fire from Veſuvius divided itſelf into two branches, and left a church untouched in the middle. There is a well at the foot of the old walls of Catania, where the lava, after running along the parapet, and then falling forwards, has produced a very complete lofty arch over the ſpring.

The church here is a noble fabric. It is accounted the largeſt in Sicily, though neither a porch nor cupola has been erected, from a doubt of the ſolidity of the foundations, which are no other than the bed of lava that ran out of Ætna in 1669, and is ſuppoſed to be full of cavities. The organ is much eſteemed by connoiſſeurs in muſical inſtruments.

Catania, according to Mr Swinburne's account, is reviving with great ſplendour. "It has already (he ſays) much more the features of a metropolis and royal reſidence than Palermo: the principal ſtreets are wide, ſtraight, and well paved with lava. An obeliſk of red granite, placed on the back of an antique elephant of touchſtone, ſtands in the centre of the great ſquare, which is formed by the townhall, ſeminary, and cathedral. The cathedral erected by the abbot Angerius in the year 1094, was endowed by Earl Roger with the territories of Catania and Ætna, for the ſmall acknowledgement of a glaſs of wine and a loaf of bread offered once a-year. It has ſuffered ſo much by earthquakes, that little of the original ſtructure remains, and the modern parts have hardly any thing except their materials to recommend them. The other religious edifices of the city are profuſely ornamented, but in a bad taſte. The ſpirit of building ſeems to have ſeized upon the people, and the prince of Biſcari's example adds freſh vigour. It were natural to ſuppoſe men would be backward in erecting new habitations, eſpecially with any degree of luxury, on ground ſo often ſhaken to its centre, and ſo often buried under the aſhes of a volcano; but ſuch is their attachment to their native ſoil, and their contempt of dangers they are habituated to, that they rebuild their houſes on the warm cinders of Veſuvius, the quaking plains of Calabria, and the black mountains of ſciarra at Catania; it is however ſurpriſing to ſee ſuch embelliſhments laviſhed in ſo dangerous a ſituation. There is a great deal of activity in the diſpoſition of this people: they know by tradition that their anceſtors carried on a flouriſhing commerce; and that before the fiery river filled it up, they had a ſpacious convenient harbour, where they now have ſcarce a creek for a felucca: they therefore wiſh to reſtore thoſe advantages to Catania, and have often applied to government for aſſiſtance towards forming a mole and port, an undertaking their ſtrength alone is unequal to; but whether the refuſal originates in the deficiencies of the public treaſury or the jealouſy of the other cities, all the projects have ended in fruitleſs applications. The number of inhabitants dwelling in Catania amounts to 30,000; the Catanians make it double: A conſiderable portion of this number appertains to the univerſity, the only one in the iſland, and the nurſery of all the lawyers." E. Long. 15. 19. N. Lat. 37. 30.

CATANZARO, a city in the kingdom of Naples, the capital of Calabria Ulterior, with a biſhop's ſee. It is the uſual reſidence of the governor of the province, and is ſeated on a mountain, in E. Long. 18. 20. N. Lat. 28. 58.

CATAPHONICS, the ſcience which conſiders the properties of reflected ſounds. See ACOUSTICS.

CATAPHORA, in *Medicine*, the ſame as COMA.

CATAPHRACTA, (from κατα, and φρασσω, *I fortify* or *arm*), in the ancient military art, a piece of heavy defenſive armour, formed of cloth or leather, fortified with iron ſcales, or links wherewith ſometimes only the breaſt, ſometimes the whole body, and ſometimes the horſe too, was covered. It was in uſe among the Sarmatians, Perſians, and other barbarians. The Romans alſo adopted it early for their foot; and, according to Vegetius, kept to it till the time of Gratian, when the military diſcipline growing remiſs, and field exerciſes and labour diſcontinued, the Roman foot thought the cataphracta as well as the helmet too great a load to bear, and therefore threw both by, chooſing rather to march againſt the enemy bare-breaſted; by which, in the war with the Goths, multitudes were deſtroyed.

CATAPHRACTÆ *Naves*, ſhips armed and covered in fight, ſo that they could not be eaſily damaged by the enemy. They were covered over with boards or planks, on which the ſoldiers were placed to defend them; the rowers ſitting underneath, thus ſcreened from the enemy's weapons.

CATAPHRACTUS, denotes a thing defended or covered on all ſides with armour.

CATAPHRACTUS, or *Cataphractarius*, more particularly denotes a horſeman, or even horſe, armed with a cataphracta. The *cataphracti equites* were a ſort of cuiraſſiers, not only fortified with armour themſelves, but having their horſes guarded with ſolid plates of braſs or other metals, uſually lined with ſkins, and wrought into plumes or other forms. Their uſe was to bear down all before them, to break in upon the enemy's ranks, and ſpread terror and havock wherever they came, as being themſelves invulnerable and ſecure from danger. But their diſadvantage was their unwieldineſs, by which, if once unhorſed or on the ground, they were unable to riſe, and thus fell a prey to the enemy.

CATAPHRYGIANS, a ſect in the ſecond century, ſo called as being of the country of Phrygia. They were orthodox in every thing, ſetting aſide this, that they took Montanus for a prophet, and Priſcilla and Maximilla for true propheteſſes, to be conſulted in every thing relating to religion; as ſuppoſing the Holy Spirit had abandoned the church. See MONTANIST.

CATAPLASMA, a poultice; from καταπλασσω, *illino*, to ſpread like a plaſter. Cataplaſms take their name ſometimes from the part to which they are applied, or effects they produce; ſo are called *anacollema*, *frontale*, *epicarpium*, *epiſpaſticum*, *veſicatorium*; and when muſtard is an ingredient, they are called *ſinapiſms*.

Theſe kinds of applications are ſofter and more eaſy than plaſters or ointments. They are formed of ſome vegetable ſubſtances, and applied of ſuch a conſiſtence as neither to adhere nor run: they are alſo more uſeful when the intention is effected by the perpetuity of the heat or cold which they contain, for they retain them longer than any other kind of compoſition.

When deſigned to *relax*, or to promote ſuppuration, they ſhould be applied warm. Their warmth, moiſture, and the obſtruction they give to perſpiration, is the method of their anſwering that end. The proper heat, when applied warm, is no more than to promote a kindly pleaſant ſenſation; for great heat prevents the deſign for which they are uſed. They ſhould be renewed as often as they cool. For relaxing and ſuppurating, none excel the white bread poultice, made with the crumb of an old loaf, a ſufficient quantity of milk to boil the bread in until it is ſoft, and a little oil; which laſt ingredient, beſides preventing the poultice from drying and ſticking to the ſkin, alſo retains the heat longer than the bread and milk alone would do. To preſerve the heat longer, the poultice, when applied, may be covered with a ſtrong ox's bladder.

When deſigned to *repel*, they ſhould be applied cold, and ought to be renewed as oft as they become warm. A proper compoſition for this end is a mixture of oatmeal and vinegar.

CATAPULTA, in antiquity, a military engine contrived for the throwing of arrows, darts, and ſtones upon the enemy.—Some of theſe engines were of ſuch force that they would throw ſtones of an hundred weight. Joſephus takes notice of the ſurpriſing effects of theſe engines, and ſays, that the ſtones thrown out of them beat down the battlements, knocked off the angles of the towers, and would level a whole file of men from one end to the other, was the phalanx ever ſo deep. This was called the

Battering CATAPULTA, and is repreſented on Plate CXXXV. This catapulta is ſuppoſed to carry a ſtone, &c. of an hundred weight; and therefore a deſcription of it will be ſufficient to explain the doctrine of all the reſt; for ſuch as threw ſtones of 500 and upwards, were conſtructed on the ſame principles.

The baſe is compoſed of two large beams 2, 3. The length of theſe beams is fifteen diameters of the bore of the capitals 9. At the two extremities of each beam, two double mortiſes are cut to receive the eight tenons of two croſs beams, each of them four of the diameters in length. In the centre of each of the beams of the baſe, and near two-thirds of their length, a hole, perfectly round, and 16 inches in diameter, ſhould be bored; theſe holes muſt be exactly oppoſite to each other, and ſhould increaſe gradually to the inſide of the beams, ſo that each of them, being 16 inches on the outſide towards the capitals 9, ſhould be $17\frac{1}{2}$ at the opening on the inſide, and the edges carefully rounded off. The capitals 9 are, in a manner, the ſoul of the machine, and ſerve to twiſt and ſtrain the cordage, which forms its principle or power of motion.

The capitals are either of caſt braſs or iron; each conſiſting of a wheel with teeth, C 10, of $2\frac{1}{2}$ inches thick. The hollow or bone of theſe wheels ſhould be $11\frac{1}{4}$ inches in diameter, perfectly round, and the edges ſmoothed down. As the friction would be too great if the capitals rubbed againſt the beams by the extreme ſtraining of the cordage, which draws them towards theſe beams, that inconvenience is remedied by the means of eight friction wheels, or cylinders of braſs, about the 13th of an inch in diameter, and an inch and one ſixth in length, placed circularly, and turning upon axes, as repreſented at D 13, B 12. One of theſe friction wheels at large with its ſcrew, by which it is faſtened into the beam, is repreſented at A.

Upon this number of cylindrical wheels the capitals 9 muſt be placed in the beams 2, 3, ſo that the cylinders

ders do not extend to the teeth of the wheels, which muſt receive a ſtrong pinion 14. By means of this pinion the wheel of the capital is made to turn for ſtraining the cordage with the key 15. The capital wheel has a ſtrong catch 16, and another of the ſame kind may be added, to prevent any thing from giving way through the extreme and violent force of the ſtrained cordage.

The capital piece of the machine is a nut or croſs pin of iron, 17, ſeen at C, and hammered cold into its form. It divides the bore of the capitals exactly in two equal parts, and fixed in grooves about an inch deep. This piece, or nut, ought to be about two inches and one third thick at the top 18, as repreſented in the ſection at B; and rounded off and poliſhed as much as poſſible, that the cords folded over it may not be hurt or cut by the roughneſs or edges of the iron. Its height ought to be eight inches, decreaſing gradually in thickneſs to the bottom, where it ought to be only one inch. It muſt be very exactly inſerted in the capitals.

After placing the two capitals in the holes of the two beams in a right line with each other, and fixing the two croſs diametrical nuts or pieces over which the cordage is to wind, one end of the cord is reeved through a hole in one of the capitals in the baſe, and made faſt to a nail withinſide of the beam. The other ſide of the cord is then carried through the hole in the oppoſite beam and capital, and ſo wound over the croſs pieces of iron in the centre of the two capitals, till they are full, the cordage forming a large ſkain. The tenſion or ſtraining of the cordage ought to be exactly equal, that is, the ſeveral foldings of the cord over the capital pieces ſhould be equally ſtrained, and ſo near each other as not to leave the leaſt ſpace between them. As ſoon as the firſt folding or ſkain of cord has filled up one whole ſpace or breadth of the capital pieces, another muſt be carried over it; and ſo on, always equally ſtraining the end till no more will paſs through the capitals, and the ſkain of cordage entirely fills them, obſerving to rub it from time to time with ſoap.

At three or four inches behind the cordage, thus wound over the capital pieces, two very ſtrong upright beams 21 are raiſed: theſe are poſts of oak 14 inches thick, croſſed over at top by another of the ſame ſolidity. The height of the upright beams is 7½ diameters; each ſupported behind with very ſtrong props 25, fixed at bottom in the extremities of the baſe 2, 3. The croſs beam 24 is ſupported in the ſame manner by a prop in the centre.

The tree, arm, or ſtylus 22, ſhould be of ſound aſh. Its length is from 15 to 16 diameters of the bore of the capitals. The end at the bottom, or that fixed in the middle of the ſkain, is 10 inches thick, and 14 broad. To ſtrengthen the arm or tree, it ſhould be wrapped round with a cloth dipped in ſtrong glue like the tree of a ſaddle, and bound very hard with waxed thread of the fixth of an inch in diameter, from the large end at bottom, almoſt to the top, as repreſented in the figure.

At the top of the arm, juſt under the iron hand or receiver 27, a ſtrong cord is faſtened, with two loops twiſted one within another, for the greater ſtrength. Into theſe two loops the hook of a braſs pully 28 is put. The cord 29 is then reeved through the pully, and faſtened to the roll 30. The cock or trigger 31, which ſerves as a ſtay, is then brought to it, and made faſt by its hook to the extremity of the hand 27, in which the body to be diſcharged is placed. The pully at the neck of the arm is then unhooked; and when the trigger is to let it off, a ſtroke muſt be given upon it with an iron bar or crow of about an inch in diameter; on which the arm flies up with a force almoſt equal to that of a modern mortar. The cuſhion or ſtomacher 23, placed exactly in the middle of the croſs beam 24, ſhould be covered with tanned ox-hide, and ſtuffed with hair, the arm ſtriking againſt it with inconceivable force. It is to be obſerved, that the tree or arm 22 deſcribes an angle of 90 degrees, beginning at the cock, and ending at the ſtomacher or cuſhion.

Catapulta for Arrows, Spears, or Darts. Some of the ſpears, &c. thrown by theſe engines, are ſaid to have been 18 feet long, and to have been thrown with ſuch velocity as to take fire in their courſe.

Fig 2.

ABCD is the frame that holds the darts or arrows, which may be of different numbers, and placed in different directions. EF is a large and ſtrong iron ſpring, which is bent by a rope that goes over three pulleys, I, K, L; and is drawn by one or ſeveral men; this rope may be faſtened to a pin at M. The rope, therefore, being ſet at liberty, the ſpring muſt ſtrike the darts with great violence, and ſend them, with ſurpriſing velocity, to a great diſtance. This inſtrument differs in ſome particulars from the deſcription we have of that of the ancients; principally in the throwing of ſeveral darts at the ſame time, one only being thrown by theirs.

CATARACT, in *Hydrography*, a precipice in the channel of a river, cauſed by rocks, or other obſtacles, ſtopping the courſe of the ſtream, from whence the water falls with greater noiſe and impetuoſity. The word comes from καταϱϱασσω, "I tumble down with violence;" compounded of κατα, "down," and ϱασσω, *dejicio*, "I throw down."—Such are the cataracts of the Nile, the Danube, Rhine, &c. In that of Niagara, the perpendicular fall of the water is 137 feet: and in that of Piſtil Rhaiadr, in North Wales, the fall of water is near 240 feet from the mountain to the lower pool.

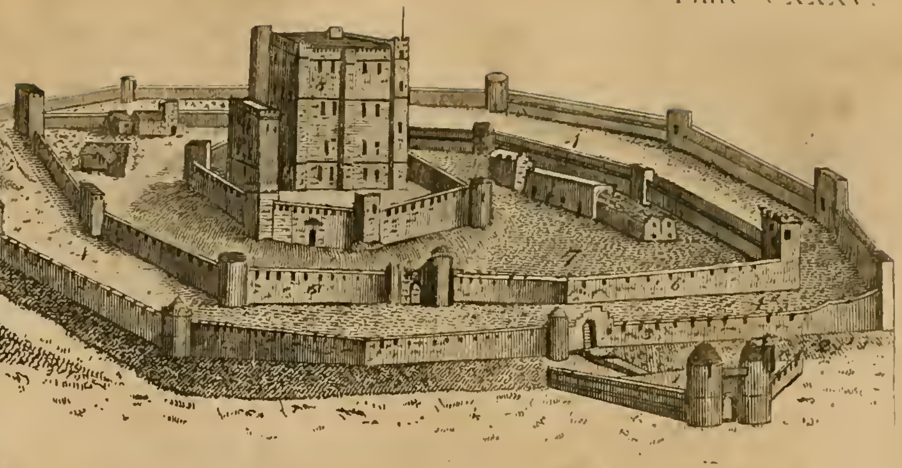
Strabo calls that a *cataract* which we call a *caſcade*; and what we call a *cataract*, the ancients uſually called a *catadupa*. Herminius has an expreſs diſſertation, "De admirandis mundi Cataractis ſupra et ſubterraneis;" where he uſes the word in a new ſenſe; ſignifyigg, by cataract, any violent motion of the elements.

Cataract, in *Medicine* and *Surgery*, a diſorder of the humours of the eye, by which the pupilla, that ought to appear tranſparent and black, looks opaque, blue, gray, brown, &c. by which viſion is variouſly impeded, or totally deſtroyed. See Surgery.

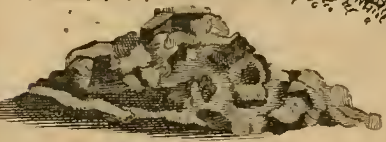
CATARO, a town of Dalmatia, and capital of the territory of the ſame name, with a ſtrong caſtle, and a biſhop's ſee. It is ſubject to Venice, and is ſeated on a gulf of the ſame name. E. Long. 19. 19. N. Lat. 42. 25.

CATARACTES, the trivial name of a ſpecies of Larus. See Ornithology *Index*.

CATARRH,

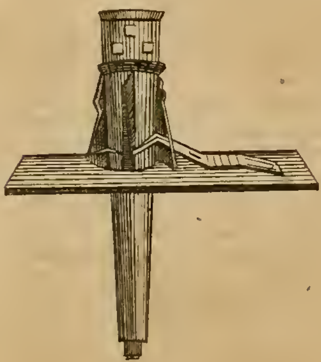


Cairn.



Capstern.

N.º 1.



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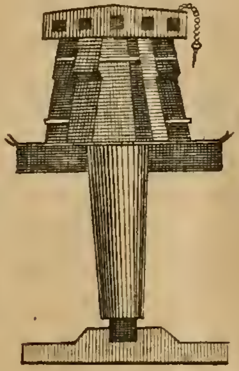

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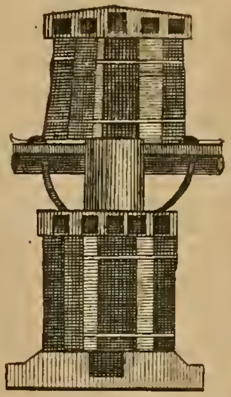

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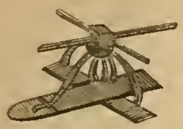
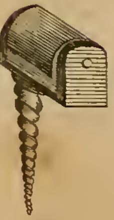
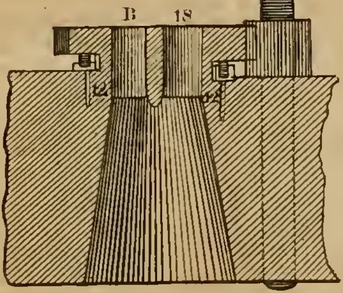


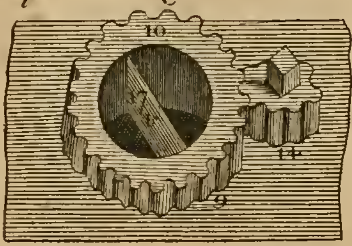
Catapulta.

A





C



D

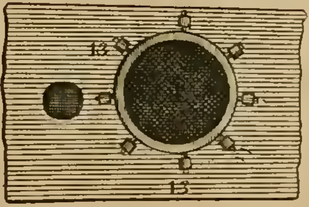


Fig. 1.

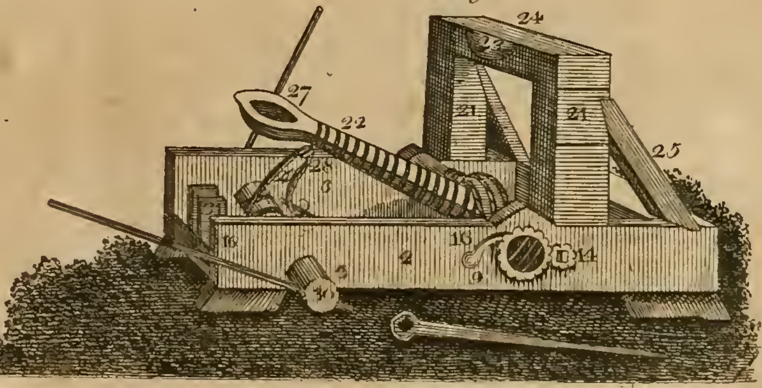
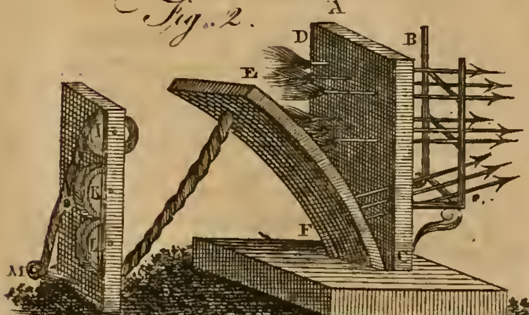


Fig. 2.



A.Bell Prin. Hall Sculptor fecit.

CATARRH, *in Medicine*, a diſtillation or defluxion from the head upon the mouth and aſpera arteria, and through them upon the lungs. See MEDICINE *Index*.

CATASTASIS, in *Poetry*, the third part of the ancient drama; being that wherein the intrigue, or action, ſet forth in the epitaſis, is ſupported, carried on, and heightened, till it be ripe for the unravelling in the cataſtrophe. Scaliger defines it, the full growth of the fable, while things are at a ſtand in that confuſion to which the poet has brought them.

CATASTROPHE, in *Dramatic Poetry*, the fourth and laſt part in the ancient drama; or that immediately ſucceeding the cataſtaſis: or, according to others, the third only; the whole drama being divided into protaſis, epitaſis, and cataſtrophe; or in the terms of Ariſtotle, prologue, epilogue, and exode.

The cataſtrophe clears up every thing, and is nothing elſe but the diſcovery or winding-up of the plot. It has its peculiar place: for it ought entirely to be contained, not only in the laſt act, but in the very concluſion of it: and when the plot is finiſhed, the play ſhould be ſo alſo. The cataſtrophe ought to turn upon a ſingle point, or ſtart up on a ſudden.

The great art in the cataſtrophe is, that the clearing up of all difficulties may appear wonderful, and yet eaſy, ſimple, and natural.

It is a very prepoſterous artifice in ſome writers to ſhow the cataſtrophe in the very title of the play. Mr Dryden thinks that a cataſtrophe reſulting from a mere change in the ſentiments and reſolutions of a perſon, without any other machinery, may be ſo managed as to be exceedingly beautiful.

It is a diſpute among the critics, whether the cataſtrophe ſhould always fall out favourably on the ſide of virtue or not. The reaſons on the negative ſide ſeem the ſtrongeſt. Ariſtotle prefers a ſhocking cataſtrophe to a happy one.—The cataſtrophe is either ſimple or complex. The firſt is that in which there is no change in the ſtate of the principal perſons, nor any diſcovery or unravelling, the plot being only a mere paſſage out of agitation into quiet repoſe. In the ſecond, the principal perſons undergo a change of fortune, in the manner already defined.

CATCH, in the muſical ſenſe of the word, a fugue in uniſon, wherein, to humour ſome conceit in the words, the melody is broken, and the ſenſe interrupted in one part, and caught again or ſupported by another; as in the catch in Shakeſpeare's play of the Twelfth Night, where there is a catch ſung by three perſons, in which the humour is, that each who ſings, calls and is called *knave* in turn: Or, as defined by Mr Jackſon "a catch is a piece for three or more voices, one of which leads, and the others follow in the ſame notes. It muſt be ſo contrived, that reſts (which are made for that purpoſe) in the muſic of one line be filled up with a word or two from another line; theſe form a croſs purpoſe, or catch, from whence the name."

Catch-Fly. See LYCHNIS, BOTANY *Index*.

Catch Pole, (quaſi one that *catches* by the *pole*), a term uſed, by way of reproach, for the bailiff's follower or aſſiſtant.

Catch-Word, among printers, that placed at the bottom of each page, being always the firſt word of the following page.

CATECHESIS, in a general ſenſe, denotes an inſtruction given any perſon in the firſt rudiments of an art or ſcience; but more particularly of the Chriſtian religion. In the ancient church, catecheſis was an inſtruction given *viva voce*, either to children, or adult heathens, preparatory to their receiving of baptiſm. In this ſenſe, *catecheſis* ſtands contradiſtinguiſhed from *myſtagogica*, which were a higher part of inſtruction given to thoſe already initiated, and containing the myſteries of faith. Thoſe who give ſuch inſtructions are called *catechiſts*; and thoſe who receive them, *catechumens*.

CATECHETIC, or CATECHETICAL, ſomething that relates to oral inſtruction in the rudiments of Chriſtianity.—Catechetic ſchools were buildings appointed for the office of the catechiſt, adjoining to the church, and called *catechumena*: ſuch was that in which Origen and many other famous men read catehetical lectures at Alexandria. See CATECHUMEN.

CATECHISM, in its primary ſenſe, an inſtruction, or inſtitution, in the principles of the Chriſtian religion, delivered *viva voce*, and ſo as to require frequent repetitions, from the diſciple or hearer, of what has been ſaid. The word is formed from κατηχεω, a compound of κατα and ηχος, q. d. *circumſono*, alluding to the noiſe or din made in this ſort of exerciſe, or to the zeal and earneſtneſs wherewith things are to be inculcated over and over on the learners.—Anciently the candidates for baptiſm were only to be inſtructed in the ſecrets of their religion by tradition *viva voce*, without writing; as had alſo been the caſe among the Egyptian prieſts, and the Britiſh and Gauliſh druids, who only communicated the myſteries of their theology by word of mouth.

CATECHISM is more frequently uſed in modern times for an elementary book, wherein the principal articles of religion are ſummarily delivered in the way of queſtion and anſwer.

CATECHIST, (κατεχιςης, *catecheta*), he that catechiſes, i. e. he that inſtructs novices in the principles of religion.

CATECHIST more particularly denotes a perſon appointed by the church to inſtruct thoſe intended for baptiſm, by word of mouth, in the fundamental articles of the Chriſtian faith.—The catechiſts of churches were miniſters uſually diſtinct from the biſhops and preſbyters, and had their auditories or *catechumena* apart. Their buſineſs was to inſtruct the catechumens, and prepare them for the reception of baptiſm. But the catechiſts did not conſtitute any diſtinct order of the clergy, but were choſen out of any other order. The biſhop himſelf ſometimes performed the office; at other times preſbyters, or even readers or deacons, were the catechiſts. Origen ſeems to have had no higher degree in the church than reader, when he was made catechiſt at Alexandria, being only 18 years of age, and conſequently incapable of the deaconſhip.

CATECHU, in the *Materia Medica*, a name given to the extract otherwiſe known by the name of *Terra Japonica*, or Japan earth. See *ARECA* and *MIMOSA*.

CATECHUMEN, a candidate for baptiſm, or one who prepares himſelf for the receiving thereof.

The catechumens, in church hiſtory, were the loweſt order of Chriſtians in the primitive church. They had ſome title to the common name of Chriſtian, being a degree above pagans and heretics, though not conſummated by baptiſm. They were admitted to the ſtate of catechumens by the impoſition of hands, and the ſign of the croſs. The children of believing parents were admitted catechumens, as ſoon as ever they were capable of inſtruction: but at what age thoſe of heathen parents might be admitted, is not ſo clear. As to the time of their continuance in this ſtate, there were no general rules fixed about it; but the practice varied according to the difference of times and places, and the readineſs and proficiency of the catechumens themſelves.

There were four orders or degrees of catechumens; the firſt were thoſe inſtructed privately without the church, and kept at a diſtance, for ſome time, from the privilege of entering the church, to make them the more eager and deſirous of it. The next degree were the *audientes*, ſo called from their being admitted to hear ſermons, and the Scriptures read in the church, but were not allowed to partake of the prayers. The third ſort of catechumens were the *genu-flectentes*, ſo called becauſe they received impoſition of hands kneeling. The fourth order was the *competentes et electi*, denoting the immediate candidates for baptiſm, or ſuch as were appointed to be baptiſed the next approaching feſtival; before which, ſtrict examination was made into their proficiency under the ſeveral ſtages of catechetical exerciſes.

After examination, they were exerciſed for twenty days together, and were obliged to faſting and confeſſion: ſome days before baptiſm they went veiled; and it was cuſtomary to touch their ears, ſaying, *Ephatha*, i. e. Be opened; as alſo to anoint their eyes with clay; both ceremonies being in imitation of our Saviour's practice, and intended to ſhadow out to the catechumens their condition both before and after their admiſſion into the Chriſtian church.

CATEGORICAL, in a general ſenſe, is applied to thoſe things ranged under a CATEGORY.

CATEGORICAL alſo imports a thing to be abſolute, and not relative; in which ſenſe it ſtands oppoſed to *hypothetical*. We ſay, a *categorical* propoſition, a *categorical* ſyllogiſm, &c.

A *categorical* anſwer denotes an expreſs and pertinent anſwer made to any queſtion or objection propoſed.

CATEGORY, in *Logic*, a ſeries or order of all the predicates or attributes contained under any genus.

The ſchool philoſophers diſtribute all the objects of our thoughts and ideas into certain *genera* or claſſes, not ſo much, ſay they, to learn what they do not know, as to communicate a diſtinct notion of what they do know; and theſe claſſes the Greeks called *categories*, and the Latins *predicaments*.

Ariſtotle made ten categories, viz. ſubſtance, quantity, quality, relation, action, paſſion, time, place, ſituation, and habit, which are uſually expreſſed by the following technical diſtich:

Arbor, ſex, ſervos, ardore, refrigerat, uſtos,
Rure cras ſtabo, nec tunicatus ero.

CATEK. See BENGAL.

CATENARIA, in the higher geometry, the name of a curve line formed by a rope hanging freely from two points of ſuſpenſion, whether the points be horizontal or not. See FLUXIONS.

CATERPILLAR, in *Zoology*, the name of all winged inſects when in their reptile or worm ſtate. See ENTOMOLOGY *Index*.

Method of Deſtroying CATERPILLARS *on Trees*.—Take a chafing diſh with lighted charcoal, and placing it under the branches that are loaded with caterpillars, throw ſome pinches of brimſtone upon the coals. The vapour of the ſulphur, which is mortal to theſe inſects, will not only deſtroy all that are on the tree, but prevent it from being infeſted with them afterwards. A pound of ſulphur will clear as many trees as grow on ſeveral acres. This method has been ſucceſsfully tried in France. In the *Journal Oeconomique*, the following is ſaid to be infallible againſt the caterpillars feeding on cabbage, and perhaps may be equally ſerviceable againſt thoſe that infeſt other vegetables. Sow with hemp all the borders of the ground where you mean to plant your cabbage; and, although the neighbourhood is infeſted with caterpillars, the ſpace encloſed with the hemp will be perfectly free, not one of the vermine will approach it.

Caterpillar-Eaters, a name given by ſome authors to a ſpecies of worms bred in the body of the caterpillar, and which eat its fleſh; theſe are owing to a certain kind of fly that lodges her eggs in the body of this animal, and they, after their proper changes, become flies like their parents.

M. Reaumur has given us, in his hiſtory of inſects, ſome very curious particulars in regard to theſe little worms. Every one of them, he obſerves, ſpins itſelf a very beautiful caſe of a cylindric figure, made of a very ſtrong ſort of ſilk; theſe are the caſes in which this animal ſpends its ſtate of chryſalis; and they have a mark by which they may be known from all other animal productions of this kind, which is, that they have always a broad ſtripe or band ſurrounding their middle, which is black when the reſt of the caſe is white, and white when that is black. M. Reaumur has had the pains and patience to find out the reaſon of this ſingularity, which is this: the whole ſhell is ſpun of a ſilk produced out of the creature's body; this at firſt runs all white, and towards the end of the ſpinning turns black. The outſide of the caſe muſt neceſſarily be formed firſt, as the creature works from within: conſequently this is truly white all over, but it is tranſparent, and ſhows the laſt ſpun or black ſilk through it. It might be ſuppoſed that the whole inſide of the ſhell ſhould be black; but this is not the caſe: the whole is faſhioned before this black ſilk comes; and this is employed by the creature, not to line the whole, but to fortify certain parts only; and therefore is all applied either to the middle, or to the two ends omitting the middle; and ſo gives either a black band in the middle, or a blackneſs at both ends, leaving the white in the middle to appear. It is not unfrequent to find a ſort of ſmall caſes, lying about garden walks, which move of themſelves; when theſe are opened, they are found to contain a ſmall living worm. This is one of the ſpecies of thoſe caterpillar-eaters; which, as ſoon as it comes out of the body of that animal, ſpins itſelf a caſe for its tranſformation long before that happens, and lives in it without food till that change comes on; and it becomes a fly like that to which it owed its birth.

CATERVA, in ancient military writers, a term uſed in ſpeaking of the Gauliſh or Celtiberian armies, denoting a body of 6000 armed men. The word *caterva*, or *catervarius*, is alſo frequently uſed by ancient writers to denote a party or corps of ſoldiers in diſorder or diſarray; by which it ſtands diſtinguiſhed from cohort or turma, which were in good order.

CATESBÆA, the LILY THORN. See BOTANY *Index*.

CATHÆRETICS, in *Pharmacy*, medicines of a cauſtic nature, ſerving to eat off fungous fleſh.

CATHARINE. *Knights of St CATHARINE of Mount Sinai*, an ancient military order, erected for the aſſiſtance and protection of pilgrims going to pay their devotion to the body of St Catharine, a virgin of Alexandria, diſtinguiſhed for her learning, and ſaid to have ſuffered martyrdom under Maximin. The body of the martyr having been diſcovered on Mount Sinai, cauſed a great concourſe of pilgrims; and travelling being very dangerous, by reaſon of the Arabs, an order of knighthood was erected in 1063, on the model of that of the holy ſepulchre, and under the patronage of St Catharine; the knights of which obliged themſelves by oath to guard the body of the ſaint, keep the roads ſecure, obſerve the rule of St Baſil, and obey their grand maſter. Their habit was white, and on it were repreſented the inſtruments of martyrdom whereby the ſaint had ſuffered; viz. a half wheel armed with ſpikes, and traverſed with a ſword ſtained with blood.

CATHARINE. *Fraternity of St Catharine at Sienna*, a ſort of religious ſociety, inſtituted in that city in honour of St Catharine, a ſaint famous for her revelations, and for her marriage with Jeſus Chriſt, whoſe wedding ring is ſtill preſerved as a valuable relick. This fraternity yearly endows a certain number of deſtitute virgins, and has the privilege of redeeming annually two criminals condemned for murder, and the ſame number of debtors, by paying their debts.

CATHARTICS, in *Medicine*, remedies which promote evacuation by ſtool. See MATERIA MEDICA.

CATHEDRA, in a general ſenſe, a chair.—The word is more particularly uſed for a profeſſor's chair, and a preacher's pulpit.

CATHEDRA is alſo uſed for the biſhop's ſee, or throne in a church.

CATHEDRAL, a church wherein is a biſhop's ſee or ſeat: See CHURCH and BISHOP. The word comes from the Greek καθεδρα, "chair," of καθεζομαι, *ſedeo*, "I ſit." The denomination *cathedral* ſeems to have taken its riſe from the manner of ſitting in the ancient churches, or aſſemblies of primitive Chriſtians: in theſe, the council, i. e. the elders and prieſts, was called *Preſbyterium*; at their head was the biſhop, who held the place of chairman, *Cathedralis* or *Cathedraticus*; and the preſbyters, who ſat on either ſide, were alſo called by the ancient fathers, *Aſſeſſores Epiſcoporum*. The epiſcopal authority did not reſide in the biſhop alone; but in all the preſbyters, whereof the biſhop was preſident. A *cathedral*, therefore, originally, was different from what it is now; the Chriſtians, till the time of Conſtantine, having no liberty to build any temple: by their churches they only meant their aſſemblies; and by *cathedrals*, nothing more than conſiſtories

CATHERINE PARR. See PARR.

CATHERINE. I. *Empreſs of Ruſſia*, a moſt extraordinary perſonage, whoſe hiſtory deſerves to be given in detail. She was the natural daughter of a country girl; and was born at Ringen, a ſmall village upon the lake Virtcherve, near Dorpt, in Livonia. The year of her birth is uncertain; but, according to her own account, ſhe came into the world on the 5th of April 1687. Her original name was Martha, which ſhe changed for Catherine when ſhe embraced the Greek religion. Count Roſen, a lieutenant-colonel in the Swediſh ſervice, who owned the village of Ringen, ſupported, according to the cuſtom of the country, both the mother and the child; and was, for that reaſon, ſuppoſed by many perſons to have been her father. She loſt her mother when ſhe was but three years old; and, as Count Roſen died about the ſame time, ſhe was left in ſo deſtitute a ſituation, that the pariſh-clerk of the village received her into his houſe. Soon afterwards Gluck, Lutheran miniſter of Marienburgh, happening, in a journey through thoſe parts, to ſee the foundling, took her under his protection, brought her up in his family, and employed her in attending his children. In 1701, and about the 14th year of her age, ſhe eſpouſed a dragoon of the Swediſh garriſon of Marienburgh. Many different accounts are given of this tranſaction: one auther of great credit affirms that the bride and bridegroom remained together eight days after their marriage; another, of no leſs authority, aſſerts, on the contrary, that on the morning of the nuptials her huſband being ſent with a detachment for Riga, the marriage was never conſummated. Thus much is certain, that the dragoon was abſent when Marienburgh ſurrendered to the Ruſſians, and Catherine, who was reſerved for a higher fortune, never ſaw him more.

General Bauer, upon the taking of Marienburgh, ſaw Catherine among the priſoners; and, being ſmitten with her youth and beauty, took her to his houſe, where ſhe ſuperintended his domeſtic affairs, and was ſuppoſed to be his miſtreſs. Soon afterwards ſhe was removed into the family of Prince Menzikof, who was no leſs ſtruck with the attractions of the fair captive. With him ſhe lived until 1704; when, in the 17th year of her age, ſhe became the miſtreſs of Peter the Great, and won ſo much upon his affections, that he eſpouſed her on the 29th of May 1711. The ceremony was ſecretly performed at Jawerof in Poland, in the preſence of General Bruce; and on the 20th of February 1712, it was publicly ſolemnized with great pomp at Peterſburgh.

Catherine, by the moſt unwearied aſſiduity and unremitted attention, by the ſoftneſs and complacency of her diſpoſition, but above all by an extraordinary livelineſs and gaiety of temper, acquired a wonderful aſcendency over the mind of Peter. The latter was ſubject to occaſional horrors, which at times rendered him gloomy and ſuſpicious, and raiſed his paſſions to ſuch a height as to produce a temporary madneſs. In theſe dreadful moments Catherine was the only perſon who durſt venture to approach him; and ſuch was the kind of faſcination ſhe had acquired over his ſenſes, that her preſence had an inſtantaneous effect, and the firſt ſound of her voice compoſed his mind and calmed his agonies. From theſe circumſtances ſhe ſeemed neceſſary not only to his comfort, but even to his very exiſtence; ſhe became his inſeparable companion on his journeys to foreign countries, and even in all his military expeditions.

The peace of Pruth, by which the Ruſſian army was reſcued from certain deſtruction, has been wholly attributed to Catherine, though ſhe was little more than an inſtrument in procuring the conſent of Peter. The latter, in his campaign of 1711 againſt the Turks, having imprudently led his troops into a diſadvantageous ſituation, took the deſperate reſolution of cutting his way through the Turkiſh army in the night. With this reſolution he retired to his tent in an agony of deſpair, and gave poſitive orders that no one ſhould be admitted under pain of death. In this important juncture the principal officers and the vice-chancellor Shaffirof aſſembled in the preſence of Catherine, and drew up certain preliminaries in order to obtain a truce from the grand vizier. In conſequence of this determination, plenipotentiaries were immediately diſpatched, without the knowledge of Peter, to the grand vizier, and a peace obtained upon more reaſonable conditions than could have been expected. With theſe conditions Catherine, notwithſtanding the orders iſſued by Peter, entered his tent, and prevailed upon him to ſign them. Catherine, by her conduct on this occaſion, acquired great popularity; and the emperor particularly ſpecifies her behaviour at Pruth as one of the reaſons which induced him to crown her publicly at Moſcow with his own hand. This ceremony was performed in 1724; and although deſigned by Peter only as a proof of his affection, was the principal cauſe of her ſubſequent elevation.

Her influence continued undiminiſhed until a ſhort time before the death of the emperor, when ſome circumſtances happened which occaſioned ſuch a coldneſs between them as would probably have ended in a total rupture, if his death had not fortunately intervened. The original cauſe of this miſunderſtanding aroſe from the following diſcovery of a ſecret connection between Catherine and her firſt chamberlain, whoſe name was Mons. The emperor, who was ſuſpicious of this connection, quitted Peterſburgh under pretence of removing to a villa for a few days, but privately returned to his winter palace in the capital. From thence he occaſionally ſent one of his confidential pages with a complimentary meſſage to the empreſs, as if he had been in the country, and with ſecret orders to obſerve her motions. From the page's information the emperor, on the third night, ſurpriſed Catherine in an arbour of the garden with her favourite Mons; while his ſiſter, Madame Balke, who was firſt lady of the bedchamber to the empreſs, was, in company with a page, upon the watch without the arbour.

Peter, whoſe violent temper was inflamed by this diſcovery, ſtruck Catherine with his cane, as well as the page, who endeavoured to prevent him from entering the arbour, and then retired without uttering a ſingle word either to Mons or his ſiſter. A few days after this tranſaction theſe perſons were taken into cuſtody, and Mons was carried to the winter palace, where no one had admiſſion to him but Peter, who himſelf brought him his proviſions. A report was at the ſame time circulated, that they were impriſoned for having received bribes, and making their influence over the empreſs ſubſervient to their own mercenary views. Mons being examined by Peter, in the preſence of Major-general Uſchacof, and threatened with the torture, confeſſed the corruption which was laid to his charge. He was beheaded; his ſiſter received five ſtrokes of the knot, and was baniſhed into Siberia; two of her ſons, who were chamberlains, were alſo degraded, and ſent as common ſoldiers among the Ruſſian troops in Perſia. On the day ſubſequent to the execution of the ſentence, Peter conveyed Catherine in an open carriage under the gallows to which was nailed the head of Mons. The empreſs, without changing colour at this dreadful ſight, exclaimed, "What a pity it is that there is ſo much corruption among courtiers!"

This event happened in the latter end of the year 1724; and as it was ſoon followed by Peter's death, and Catherine upon her acceſſion recalled Madame Balke, it has been ſuſpected that ſhe ſhortened the days of her huſband by poiſon. But notwithſtading the critical ſituation for Catherine in which he died, and her ſubſequent elevation, this charge is totally deſtitute of the leaſt ſhadow of proof; for the circumſtances of Peter's diſorder were too well known, and the peculiar ſymptoms of his laſt illneſs ſufficiently account for his death, without the neceſſity of recurring to poiſon.

While Peter was yet lying in the agonies of death, ſeveral oppoſite parties were caballing to diſpoſe of the crown. At a conſiderable meeting of many among the principal nobility, it was ſecretly determined, on the moment of his diſſolution, to arreſt Catherine, and to place Peter Alexievitch upon the throne. Baſſevitz, appriſed of this reſolution, repaired in perſon to the empreſs, although it was already night. "My grief and conſternation," replied Catherine, "render me incapable of acting myſelf: do you and Prince Menzikof conſult together, and I will embrace the meaſures which you ſhall approve in my name." Baſſevitz, finding Menzikof aſleep, awakened and informed him of the preſſing danger which threatened the empreſs and her party. As no time remained for long deliberation, the prince inſtantly ſeized the treaſure, ſecured the fortreſs, gained the officers of the guards by bribes and promiſes, alſo a few of the nobility, and the principal clergy. Theſe partizans being convened in the palace, Catherine made her appearance; ſhe claimed the throne in right of her coronation at Moſcow; ſhe expoſed the ill effects of a minority; and promiſed, that, "ſo far from depriving the great duke of the crown, ſhe would receive it only as a ſacred depoſit, to be reſtored to him when ſhe ſhould be united, in another world, to an adored huſband, whom ſhe was now upon the point of loſing."

The

Catherine.

The pathetic manner with which ſhe uttered this addreſs, and the tears which accompanied it, added to the previous diſtribution of large ſums of money and jewels, produced the deſired effect: at the cloſe of this meeting the remainder of the night was employed in making the neceſſary preparations to enſure her acceſſion in caſe of the emperor's death.

Peter at length expired on the morning of the 28th of January 1725. This event being made known, the ſenate, the generals, the principal nobility and clergy, haſtened to the palace to proclaim the new ſovereign. The adherents of the great duke ſeemed ſecure of ſucceſs, and the friends of Catherine were avoided as perſons doomed to deſtruction. At this juncture Baſſevitz whiſpered one of the oppoſite party, "The empreſs is miſtreſs of the treaſure and the fortreſs; ſhe has gained over the guards and the ſynod, and many of the chief nobility; even here ſhe has more followers than you imagine; adviſe therefore your friends to make no oppoſition as they value their heads." This information being rapidly circulated, Baſſevitz gave the appointed ſignal, and the two regiments of guards, who had been gained by a largeſs to declare for Catherine, and had already ſurrounded the palace, beat to arms. "Who has dared (exclaimed Prince Repnin, the commander in chief), to order out the troops without my knowledge?" "I, (returned General Butterlin), without pretending to diſpute your authority, in obedience to the commands of my moſt gracious miſtreſs." This ſhort reply was followed by a dead ſilence. In this moment of ſuſpenſe and anxiety Menzikof entered, preceding Catherine, ſupported by the duke of Holſtein. She attempted to ſpeak, but was prevented by ſighs and tears from giving utterance to her words: at length, recovering herſelf, "I come (ſhe ſaid), notwithſtanding the grief which now overwhelms me, to aſſure you, that, ſubmiſſive to the will of my departed huſband, whoſe memory will be ever dear to me, I am ready to devote my days to the painful occupations of government, until Providence ſhall ſummon me to follow him." Then, after a ſhort pauſe, ſhe artfully added, "If the great duke will profit by my inſtructions, perhaps I ſhall have the conſolation, during my wretched widowhood, of forming for you an emperor worthy of the blood and the name of him whom you have now irretrievably loſt." "As this criſis (replied Menzikof) is a moment of ſuch importance to the good of the empire, and requires the moſt mature deliberation, your majeſty will permit us to confer, without reſtraint, that this whole affair may be tranſacted without reproach, as well in the opinion of the preſent age as in that of poſterity." "Acting as I do (anſwered Catherine), more for the public good than for my own advantage, I am not afraid to ſubmit all my concerns to the judgment of ſuch an enlightened aſſembly: you have not only my permiſſion to confer with freedom; but I lay my commands upon you all to deliberate maturely on this important ſubject, and I promiſe to adopt whatever may be the reſult of your deciſions." At the concluſion of theſe words the aſſembly retired into another apartment, and the doors were locked.

It was previouſly ſettled by Menzikof and his party that Catherine ſhould be empreſs; and the guards, who ſurrounded the palace with drums beating and colours flying, effectually vanquiſhed all oppoſition. The only circumſtance, therefore, which remained, was to give a juſt colour to her title, by perſuading the aſſembly that Peter intended to have named her his ſucceſſor. For this purpoſe Menzikof demanded of that emperor's ſecretary, whether his late maſter had left any written declaration of his intentions? The ſecretary replied, "That a little before his laſt journey to Moſcow he had deſtroyed a will; and that he had frequently expreſſed his deſign of making another, but had always been prevented by the reflection, that if he thought his people whom he had raiſed from a ſtate of barbariſm to a high degree of power and glory, could be ungrateful, he would not expoſe his final inclinations to the inſult of a refuſal; and that if they recollected what they owed to his labours, they would regulate their conduct by his intentions, which he had diſcloſed with more ſolemnity than could be manifeſted by any writing." An altercation now began in the aſſembly; and ſome of the nobles having the courage to oppoſe the acceſſion of Catherine, Theophanes archbiſhop of Pleſcoff called to their recollection the oath which they had all taken in 1722 to acknowledge the ſucceſſor appointed by Peter; and added, that the ſentiments of that emperor delivered by the ſecretary were in effect an appointment of Catherine. The oppoſite party, however, denied theſe ſentiments to be ſo clear as the ſecretary choſe to inſinuate; and inſiſted, that as their late monarch had failed to nominate his heir, the election of the new ſovereign ſhould revert to the ſtate. Upon this the archbiſhop farther teſtified, that the evening before the coronation of the empreſs at Moſcow, Peter had declared, in the houſe of an Engliſh merchant, that he ſhould place the crown upon her head with no other view than to leave her miſtreſs of the empire after his deceaſe. This atteſtation being confirmed by many perſons preſent, Menzikof cried out, "What need have we of any teſtament? A refuſal to conform to the inclination of our great ſovereign, thus authenticated, would be both unjuſt and criminal. Long live the empreſs Catherine!" Theſe words being inſtantaneouſly repeated by the greateſt part of thoſe who were preſent, Menzikof, ſaluting Catherine by the title of empreſs, paid his firſt obeiſance by kiſſing her hand; and his example was followed by the whole aſſembly. She next preſented herſelf at the window to the guards and to the people, who ſhouted acclamations of "Long live Catherine!" while Menzikof ſcattered among them handfuls of money. Thus (ſays a contemporary) the empreſs was raiſed to the throne by the guards, in the ſame manner as the Roman emperors by the prætorian cohorts, without either the appointment of the people or of the legions.

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The reign of Catherine may be conſidered as the reign of Menzikof, that empreſs having neither inclination or abilities to direct the helm of government; and ſhe placed the moſt implicit confidence in a man who had been the original author of her good fortune, and the ſole inſtrument of her elevation to the throne.

During her ſhort reign her life was very irregular; ſhe was extremely averſe to buſineſs; would frequently, when the weather was fine, paſs whole nights in the open air; and was particularly intemperate in the

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uſe of tokay wine. Theſe irregularities, joined to a cancer and a dropſy, haſtened her end; and ſhe expired on the 17th of May 1727, a little more than two years after her acceſſion to the throne, and in about the 40th year of her age.

As the deaths of ſovereigns in deſpotic countries are ſeldom imputed to natural cauſes, that of Catherine has alſo been attributed to poiſon; as if the diſorders which preyed upon her frame were not ſufficient to bring her to her grave. Some aſſert that ſhe was poiſoned in a glaſs of ſpirituous liquor; others by a pear given her by General Diever. Suſpicions alſo fell upon Prince Menzikof, who, a ſhort time before her deceaſe, had a trifling miſunderſtanding with her, and who was accuſed of haſtening her death, that he might reign with ſtill more abſolute power during the minority of Peter II. But theſe reports deſerve not the leaſt credit, and were merely dictated by the ſpirit of party, or by popular rumour.

Catherine was in her perſon under the middle ſize, and in her youth delicate and well formed, but inclined to corpulency as ſhe advanced in years. She had a fair complexion, dark eyes, and light hair, which ſhe was always accuſtomed to dye with a black colour. She could neither read nor write: her daughter Elizabeth uſually ſigned her name for her, and particularly to her laſt will and teſtament; and Count Oſterman generally put her ſignature to the public decrees and diſpatches. Her abilities have been greatly exaggerated by her panegyriſts. Gordon, who had frequently ſeen her, ſeems of all writers to have repreſented her character with the greateſt juſtneſs, when he ſays, "She was a very pretty well-looked woman, of good ſenſe, but not of that ſublimity of wit, or rather that quickneſs of imagination, which ſome people have believed. The great reaſon why the czar was ſo fond of her, was her exceeding good temper; ſhe never was ſeen peeviſh or out of humour; obliging and civil to all, and never forgetful of her former condition: withal, mighty grateful." Catherine maintained the pomp of majeſty with an air of eaſe and grandeur united; and Peter uſed frequently to expreſs his admiration at the propriety with which ſhe ſupported her high ſtation, without forgetting that ſhe was not born to that dignity.

The following anecdotes will prove that ſhe bore her elevation meekly; and, as Gordon aſſerts, was never forgetful of her former condition. When Wurmb, who had been tutor to Gluck's children at the time that Catherine was a domeſtic in that clergyman's family, preſented himſelf before her after her marriage with Peter had been publicly ſolemnized, ſhe recollected and addreſſed him with great complacency, "What, thou good man, art thou ſtill alive! I will provide for thee." And ſhe accordingly ſettled upon him a penſion. She was no leſs attentive to the family of her benefactor Gluck, who died a priſoner at Moſcow: ſhe penſioned his widow; made his ſon a page; portioned the two eldeſt daughters; and advanced the youngeſt to be one of her maids of honour. If we may believe Weber, ſhe frequently inquired after her firſt huſband; and, when ſhe lived with Prince Menzikof, uſed ſecretly to ſend him ſmall ſums of money, until, in 1705, he was killed in a ſkirmiſh with the enemy.

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But the moſt noble part of her character was her peculiar humanity and compaſſion for the unfortunate. Motraye has paid a handſome tribute to this excellence. "She had, in ſome ſort, the government of all his (Peter's) paſſions; and even ſaved the lives of a great many more perſons than Le Fort was able to do: ſhe inſpired him with that humanity which, in the opinion of his ſubjects, nature ſeemed to have denied him. A word from her mouth in favour of a wretch, juſt going to be ſacrificed to his anger, would diſarm him; but if he was fully reſolved to ſatiſfy that paſſion, he would give orders for the execution when ſhe was abſent, for fear ſhe ſhould plead for the victim." In a word, to uſe the expreſſion of the celebrated Munich, "*Elle etoit proprement la mediatrice entre le monarque et ſes ſujets.*"

Catherine II. empreſs of Ruſſia, whoſe original name was Sophia Auguſta Frederica, was the daughter of Chriſtian Auguſtus of Anhalt Zerbſt, a ſmall diſtrict in Upper Saxony, and was born in the caſtle of Zerbſt, on the 23d of May 1729. She was educated under the eye of her parents, along with her brother Prince Frederic Auguſtus, and at an early period diſplayed a maſculine ſpirit. Elegant, majeſtic, and handſome, in her perſon, her complexion exhibited the union of the lily and the roſe, while a native dignity was tempered by a ſmile of beneficence. But it was early obſerved, that ſhe concealed under this a certain auſterity of diſpoſition, and an ambition, which was even then conſidered as exceſſive, and proved afterwards to be inſatiable.

She ſoon learned all the faſhionable accompliſhments of that day. In addition to her native language, ſhe wrote and converſed in French; of muſic ſhe acquired a competent knowledge, and excelled particularly in needlework, which ſhe did not diſdain to practiſe after her elevation to the throne.

The empreſs Elizabeth, who had pitched upon her nephew the duke of Holſtein Gottorp Oldenbourg for her ſucceſſor, was alſo deſirous to chooſe a conſort for him, and the princeſs of Anhalt Zerbſt was ſelected upon this occaſion, when only fourteen years of age. She was chiefly indebted for ſo unexpected an honour to the tender regard which her imperial majeſty always entertained for the memory of her uncle, who had been her lover; and in an evil hour ſhe united the fate of the prince, better known afterwards by the name of Peter III. to that of the princeſs of Anhalt Zerbſt. In conſequence of a ſpecial invitation, the future empreſs repaired to St Peterſburgh, accompanied by her mother, and being admitted into the boſom of the Greek church, the ceremonial of marriage, after ſome delay, took place; on which theſe auguſt perſonages were formally acknowledged, by her imperial majeſty and the ſenate, as grand duke and ducheſs of Ruſſia. Elizabeth, at the ſame time, preſented them with the palace of Oranienbaum, delightfully ſituated on the gulf of Cronſtadt, as a ſummer reſidence; this had formerly belonged to Menzikof, the favourite of Peter the Great, who, in this capricious court, had been by turns a pie-boy, a prince, and an exile.

The grand duke was far from being handſome; on the contrary, his perſon was diſagreeable, and almoſt diſguſting. His education had been greatly neglected, and he was paſſionately fond of military parade. Frederick of Pruſſia was at once his friend and his model; he kept up a ſecret correſpondence with that monarch, at the time when Ruſſia was at open war with him; he was accuſtomed in his cups to kneel before a picture of his hero; and, after quaffing a bumper, he would exclaim, "My brother! we ſhall conquer the world together."

The firſt moments of this union ſeemed to be peculiarly auſpicious. The illuſtrious pair were accuſtomed to withdraw themſelves daily, as if deſirous to enjoy the pleaſure of each other's company, in preference to the giddy diſſipation of a court. It was perceived at laſt, that grandeur was not incompatible with happineſs, and that hymeneal felicity was not confined to plebeian life.

Ths empreſs hoped that the name and pretenſions of Prince Iwan would be obliterated by the iſſue of the grand duke, and the whole empire impatiently wiſhed for and now expected an heir to the throne of Peter the Great. It has ſince been diſcovered, that this young couple occupied their time in a far different manner than was then ſuſpected! His highneſs, it ſeems, retired from ſociety on purpoſe to perfect himſelf in the Pruſſian exerciſe, and his conſort on theſe occaſions participated in his diverſions, for he was accuſtomed to make her ſtand for hours together, as a centinel, with a muſquet at her ſhoulder. This ſpecies of entertainment did not altogether ſuit the diſpoſition of a young princeſs of an ardent temperament, and her highneſs accordingly began, in her own language, to think "that ſhe was made for ſomething elſe." Although ſhe did not love, ſhe at this period governed her huſband, and even concealed his foibles; imagining at firſt that ſhe could not reign but by means of him, ſhe wiſely determined to make him appear worthy of a throne.

A marriage of eight years was not productive of any iſſue, and ſtrange ſuſpicions began to be entertained. This alarmed the court, for a formidable rival, who poſſeſſed a ſuperior claim to the throne, ſtill exiſted; it is true, he was in bondage, but in a country like Ruſſia, the interval might not be long between a dungeon and a throne. The birth of a ſon and daughter, ſoon after this, put an end to all apprehenſions of this kind, and tended not a little to give ſtability to the empire.

The grand duke, who at times diſcovered noble, and even magnanimous ſentiments, had about this period formed a moſt unfortunate connexion with Elizabeth Voronſoff, a lady of high rank, but neither celebrated for her beauty nor her talents. He ſeldom ſaw his conſort in private, and all the hours that were not occupied either by military exhibitions, or the pleaſures of the table, were entirely devoted to his miſtreſs.

The grand ducheſs, on the other hand, is ſaid to have ſpent much of her time in company with a young Pole, whoſe hiſtory, like that of Catherine's, has ſince been interwoven with the annals of Europe. This was Count Poniatowſki, afterwards known as Staniſlaus Auguſtus king of Poland. He was the third ſon of a grandee of the ſame name, the favourite of Charles XII. of Sweden, by the princeſs Ezatoryſka, who boaſted the poſſeſſion of the nobleſt blood in Poland, as ſhe traced her deſcent from the Jagellon, the ancient ſovereigns of Lithuania. His perſon was of exquiſite ſymmetry, his air noble, his manners agreeable; in ſhort, he poſſeſſed a charming exterior, and his mind, a circumſtance extremely rare, was no leſs graceful than his perſon. At this period he was in no higher ſtation, than a gentleman in the ſuite of the miniſter plenipotentiary from England, who had formed an intimacy with his family during a former miſſion at Warſaw. Being now taught to look higher, he returned to his native country, and appeared ſoon after at Peterſburgh, as ambaſſador from the king of Poland. In this new capacity he did not forget to pay his reſpects at the little court of Oranienbaum, and the young plenipotentiary, with a view of ingratiating himſelf with the grand duke, ſmoked, drank, and praiſed the king of Pruſſia. At length Paul Petrowiſch received the Poliſh miniſter with coolneſs, and he was actually forbidden to viſit at the palace. This, however, it is ſaid, did not deter him from concealing the order of the white eagle, and diſguiſing himſelf as a mechanic, under which aſſumed quality he repaired one ſummer's evening to the gardens, in the neighbourhood of the gulf of Cronſtadt; but he was diſcovered by his highneſs, who ordered him to be brought before him, and, after affecting to reprimand the captain of his guard for his diſreſpect to the repreſentative of a crowned head, told him he was at liberty to depart.

From this moment the grand ducheſs is ſaid to have changed both her ſyſtem and her conduct. She had formerly aſpired only to direct the counſels of the future emperor; ſhe now reſolved, if poſſible, to obtain the crown for her ſon, and the regency for herſelf. Such a taſk would have diſcouraged a common mind, for it was impoſſible to achieve this without prevailing on the empreſs to conſent to dethrone her own nephew. Beſtuchef, the grand chancellor, who hated the heir apparent, joined cordially in their ſcheme; and Elizabeth, who herſelf had obtained the crown by means of a revolution, was taught to tremble for her life, in conſequence of the deſigns of her ſucceſſor, who was repreſented as having reſolved to ſhorten her days by poiſon. But a ſudden and unexpected revolution in the miniſtry put an end to theſe intrigues; for Beſtuchef was driven into exile, and Poniatowſki recalled.

A long and melancholy interval now enſued, during which the ambition of the grand ducheſs was rather ſuſpended than annihilated. She, however, had recourſe to, and ſoothed her anguiſh by means of books; it was in her ſtudy that ſhe laid the foundation of her future greatneſs, and rendered herſelf in ſome meaſure deſerving of a throne. During her leiſure moments ſhe found means to gain partiſans, and ſhe acquired the favour of the ſoldiery, who did duty around her perſon, by means of her liberality and condeſcenſion. Peter, on the other hand, to the perſonal exertions of a common ſoldier, added the orgies of a debauchee. Surrounded by his male and female favourites, he conſumed whole days and nights in intoxication, and forgot that he was a prince. There were ſome few moments, however, when he appeared great, and even magnanimous, but unfortunately they were of ſhort duration; and it was his misfortune to have a weak woman for his miſtreſs, and an able and ambitious one for his wife.

Such was the ſituation of the court when Elizabeth died, on the 5th of January 1762. This event, ſo productive of intereſting effects, had been long foreſeen by Catherine, who now began to act a more conſpicuous part on the theatre of public affairs. Her ſorrow, which appeared unbounded, was only equalled by her devotion. She was conſtantly employed either at her prayers in the cathedral, or occupied in public proceſſions, during which ſhe ſcrupulouſly adhered to all the ceremonious practices of the Greek church. The courtiers were aſtoniſhed at the ſudden change, and affected to ſurvey it with contempt; but it impoſed on the populace, and the prieſts were highly gratified with the zeal of the empreſs, more eſpecially as her conſort had always treated their myſteries with indignity.

Another deſign, meditated with no leſs art, proved unſucceſsful. She is ſaid to have made uſe of all her eloquence to perſuade Peter, that he ought to leave off the barbarous cuſtom of being proclaimed emperor by the army, in the ſame manner as his predeceſſors: inſtead of this, ſhe propoſed that his title ſhould be recogniſed by the ſenate alone, and produced a ſpeech which ſhe herſelf had compoſed for the occaſion; but Godowitz, one of the favourites, and the only friend of the new ſovereign, perceived the ſnare, and, partly owing to his entreaties, and partly from an attachment to every thing military, the ſoldiery were as uſual gratified with the ceremony of ſaluting the czar.

The grand duke now aſcended the throne, by the name of Peter III. and the commencement of the new reign appeared to be peculiarly auſpicious. The cataſtrophe, which terminated a ſhort reign of ſix months, may be attributed to three apparently trifling, but, in reality, irretrievable errors; for it is allowed on all hands, that if they did not conſtitute the original cauſe, they at leaſt afforded the pretext for his dethronement and murder. The firſt of theſe was, the ſudden peace with, and marked predilection for, the king of Pruſſia, certainly the greateſt monarch of his age; the ſecond, an attempt to reform a barbarous and fanatical clergy, whoſe power Peter I. had curbed, but whoſe perſons he ſtill affected to conſider as ſacred; the third was, the war againſt Denmark.

Let it be recollected, however, in honour to his memory, that the young monarch, immediately after his elevation, threw open the ſtate priſons, recalled Munich, Biron, Leſtock, and ſeveral others, who had offended him during the late reign, from Siberia; that he limited the deſpotiſm of his officers, abridged his own power, by aboliſhing a ſtate inquiſition, exerciſed under the name of *the Secret Council of Chancery*; and that he framed the memorable decree which enfranchiſed the nobles from compulſive ſervice in the army, and permitted them to travel without the royal permiſſion.

The following anſwer to a letter from the king of Pruſſia, who had requeſted him to be on his guard againſt the plot then meditating, conveys no unfavourable opinion of his heart.

"Touching the intereſt you expreſs for my ſafety, I requeſt you will reſt contented. I am called the father of my ſoldiers—they prefer a male to a female government. I walk alone conſtantly in St Peterſburgh—if any miſchief is meditated, it would have been effected long ſince; but I am a general benefactor. I repoſe myſelf on the protection of heaven; truſting to that, I have nothing to fear."

This falſe ſecurity proved his ruin. While his mind was occupied with plans of reform, and he aſpired to rival, and even to excel, his illuſtrious predeceſſor, whoſe name he had aſſumed, a perſon who had ſworn fidelity to him at the altar, and who owed allegiance by the double ties of a wife and a ſubject, was actually employed in planning a conſpiracy, and organizing a revolt, againſt him. It has been ſaid that he intended to have ſhut up his conſort and ſon in a convent. But did a meditated impriſonment juſtify treachery, treaſon, and murder? On the other hand, it is known that, ſo far from this being the intention of Peter, he was preparing for a journey to Holſtein, and had actually empowered his conſort to act as regent during his abſence.

The miſtakes of the emperor did not eſcape the eagle eyes of his enemies. He purpoſed to carry his guards into Holſtein, with a view to recover the poſſeſſions wreſted from his anceſtors. The regiments that had hitherto done duty at the palace, and were inured to the indulgences of the capital, revolted at the idea of a foreign war: they had been accuſtomed to be governed by women, and they were taught to fix their eyes on the conſort of the czar.

It is not the leaſt wonderful part of her conduct, that, previouſly to the great cataſtrophe now meditating, Catherine contrived to appear abandoned by all the world. She knew how intereſting a female, and more eſpecially an empreſs, appeared while in diſtreſs; and ſhe took care to heighten the ſenſibility of the public, by burſting at times into a flood of tears. This artful woman had found means to attach many perſons to her deſtiny: it muſt be owned, however, that her adherents were neither ſo powerful, nor ſo numerous, as to afford her any well founded hopes of ſucceſs. She had gained ſeveral ſubalterns, and ſome privates, of the guards: but her principal partiſans conſiſted of the princeſs d'Aſchekof, niece to the new chancellor; Prince Rozamouſki, who had riſen from obſcurity, having been originally a peaſant; Odart, an intriguing Italian; and Panin, governor to the grand duke. The arreſt of Paſſick, one of the conſpirators, ſeemed to lead to a diſcovery, which would have proved fatal to the malecontents; but this very circumſtance induced them to declare inſtantly, and in the end crowned an apparently raſh attempt with ſucceſs

The empreſs, who was aſleep at the caſtle of Peterſhoff, received intimation of their deſign by a common ſoldier, who ſoon after returned with a carriage and eight horſes. On the faith of this man, and accompanied only by a few peaſants, a German female domeſtic, and a French valet de chambre, ſhe arrived at eight o'clock in the morning in the capital, and ſtopped oppoſite the barracks of the regiment of Iſmailoff. There ſhe addreſſed the ſoldiers in an eloquent ſpeech, intermingled with ſighs and tears, and actually found means to perſuade them that ſhe and her ſon had but that moment eſcaped from the hands of aſſaſſins, ſent by the emperor to murder them. This ſtory, by agitating the paſſions of the troops, had a wonderful effect on them, and they all ſwore, with the exception of only one regiment, to die in defence of her and the young archduke. On this the empreſs ordered a crucifix to be brought, and commanded the prieſts to adminiſter a new oath of allegiance. She afterwards repaired to one of the principal churches, where ſhe was met by the biſhop of Novogorod and the clergy, and, having returned thanks to Almighty God, aſcended a balcony, and preſented her ſon to the people. In a few hours ſhe was again ſeen, dreſſed in the uniform of the guards, riding at the head of a numerous and well-appointed army againſt her huſband.

That unfortunate prince firſt made a ſhew of reſiſtance, and manned his Liliputian batteries, at Oranienbaum, with his Holſtein guards, in order to oppoſe what appeared to him to be a contemptible ſedition. When it was too late, he attempted to get poſſeſſion of Cronſtadt. He might ſtill have eſcaped to Revel, but the women in his galley were apprehenſive of danger, and the courtiers ſhuddered at the propoſition of old Munich, who wiſhed them to aſſiſt the ſailors in rowing.

On the firſt intelligence of the plot this intrepid warrior had repaired to his benefactor, and adviſed him to march directly to the capital, at the head of his German troops. "I ſhall precede you, (ſaid the generous veteran), and my dead body ſhall be a rampart to your ſacred perſon." But, on the other hand, the emiſſaries of the empreſs, bathing his hands in their crocodile tears, deprecated reſiſtance, magnified the danger, and invited him to repoſe in the inviolable fidelity of his conſort. In ſhort, on the 14th of July, 1762, he was taken priſoner by the orders of his own wife, to whom he had been married 14 years, prevailed on by the threats and entreaties of Count Panin to renounce his crown, conveyed to the caſtle of Robſcha, and three days afterwards put to death. Of the titled minions, who perpetrated this daring murder, one carried the guilty marks of the czar's ſcimitar on his forehead to the grave, and another, tortured for years by the remembrance of the laſt bloody ſcene in the tragedy of his expiring ſovereign, exhibited a ſhocking ſpectacle of infanity and remorſe.

The empreſs, on her aſſumption of the now vacant crown, notified the event to all the courts of Europe, under her new name of Catherine Alexiewna II. But there was ſtill a competitor for the empire, and ſuſpicion never ſlumbers near a throne. This was Prince Iwan, ſon to the princeſs of Mecklenburg, and grand nephew to Peter the Great and the empreſs Anna Iwanowna, who had deſtined him for her ſucceſſor; but, in conſequence of a former revolution, he was ſeized while yet an infant, and doomed to lead a life of captivity. During 18 years of precarious exiſtence, he had been ſhut up in the caſtle of Schluſſelbourg, and never in all that time did he breathe the open air, or behold the ſky, but once. This prince was viſited by Peter III. who finding him in an arched room, 20 feet ſquare, determined to ſet him at liberty; but, alas! the youth, in conſequence of his long and ſolitary confinement, had been deprived of his ſenſes. In this ſituation, the emperor determined to build a houſe for him, with a convenient terrace, where he might take the air daily within the fortreſs. Such, however, are the changes of fortune, that, in three weeks, he himſelf was alſo precipitated from a throne, and expoſed to a violent death. This event was but the prelude to that of Iwan; for, as orders had been given, in caſe of an attempt to reſcue him, that an end ſhould be put to his life, and a real or pretended plot having been hatched for this purpoſe, the motives and details of which have hitherto been involved in the moſt profound obſcurity, the unhappy prince experienced the ſame fate as his generous protector.

Catherine being now firmly ſeated on the throne, wiſely determined to divert the thoughts of the nation from the late horrid ſcenes, and fix them on more agreeable objects. Having ſoothed Pruſſia, acquired a preponderance in the cabinet of Denmark, long become an abſolute monarchy, and entered into a league with the popular party in Sweden, not yet bereft of its liberties, ſhe caſt her eyes on Courland, then governed by Prince Charles of Saxony, the ſecond ſon of Auguſtus III. king of Poland; and, finding that country admirably ſituated for the increaſe of her preſent, and the extenſion of her future power, ſhe, in 1762, expelled the lawful ſovereign, and inveſted Biron, a creature of her own, with the ducal cap. Not content with this, the new duke, ſoon reduced to the moſt abject dependence, was prevented from reſigning his precarious power, and the ſtates aſſembled at Mittau were actually interdicted from nominating a ſucceſſor. This, however, was only a prelude to far greater ſcenes, for ſhe had hardly dethroned one ſovereign before ſhe undertook to create another. Auguſtus II. or as he is called by ſome, Auguſtus III. of Poland, having died at Dreſden, in 1763, her imperial majeſty did not let ſlip ſo fair an opportunity for interfering in the appointment to the vacant throne, and even placing one of her dependents on it. Count Poniatowſki, on the elevation of Catherine, had ſent a friend to Peterſburgh, to ſound the diſpoſition of the empreſs about his return to that capital, where he naturally hoped to participate in her power, and baſk in the ſunſhine of the royal ſmiles. But the more prudent German, who was at this very moment meditating a ſplendid proviſion for him elſewhere, prohibited the journey from political motives. Accordingly, notwithſtanding the oppoſition of the grand chancellor Beſtucheff, and indeed of all her miniſters, ſhe determined to inveſt him with the enſigns of royalty. The head of the houſe of Brandenburgh, ſwayed by his hatred to Saxony and Auſtria, or, what is ſtill more likely, the Pruſſian eagle having perhaps, even now, ſcented his future prey, Catherine was enabled to ſend 10,000 men into Poland, who, encamping on the banks of the Viſtula, overawed the deliberations of the diet, aſſembled on the 9th of May 1764, and placed Staniſlaus-Auguſtus on the throne. Thus, by the appearance of a camp filled with Ruſſian mercenaries, was violated one of the fundamental laws of the commonwealth, eſtabliſhed ever ſince the time of Sigiſmund-Auguſtus, two centuries before, in conſequence of which the election of a king is deemed void while there are any foreign troops within the territories of the republic; and ſo juſtly jealous were the ancient Poles of their national independence, that the marſhal of the diet, on thoſe occaſions, was accuſtomed to requeſt all ambaſſadors to abſent themſelves, as he could not be anſwerable for the ſafety of their perſons.

Having conferred the crown of Poland, September 7. 1764, on an amiable and accompliſhed prince, who, on account of his youth, his poverty, and even his dependence on Ruſſia, would have been excluded from that painful pre-eminence had the free ſuffrage of the nation been collected; and who was, in conſequence of the hatred of his countrymen, ſtill more ſubjected to the dominion of the empreſs, ſhe began to prepare for a war againſt the Turks, which was accordingly declared in 1768. During this conteſt the Greek croſs was triumphant both by ſea and land. On the firſt of theſe elements her fleet, under Count Orloff, entered the ſtraits of Gibraltar, and carried terror and deſolation among the iſlands in the Archipelago, and throughout the defenceleſs ſhores of Aſia Minor; on the ſecond, her armies, under Galitzen and Romanzoff, achieved many important victories, ſeized on the fortreſs of Choczim, and prevailed on the Greek inhabitants of Wallachia and Moldavia to acknowledge her as their ſovereign.

In the mean time, however, a dangerous inſurrection broke out in the heart of her dominions, inſtigated by a Coſſack of the name of Pugatſcheff, who pretended to be Peter III. After diſplaying great valour and conſiderable talents, which had enabled him, at the head of raw and undiſciplined levies, to contend againſt veteran troops and experienced generals, this unfortunate man was at length ſeized, encloſed in an iron cage, and beheaded at Moſcow on the 21ſt of January 1775.

A peace had been concluded on the 21ſt of July, in the preceding year, with the Porte, which proved highly honourable to Ruſſia; but it was productive of little benefit, for the liberty of navigating the Black ſea, and a free trade with all the ports of the Turkiſh empire, which would have afforded ineſtimable advantages to a civilized people, was ſcarcely of any conſequence to a nation unacquainted alike with commerce and manufactures.

Accordingly, we find her imperial majeſty ſtill unſatisfied. Ambition, which in a female boſom is ever inſatiable, ſtimulated her to attempt new acquiſitions, and we learn with aſtoniſhment that her diplomatic artifices proved infinitely more hoſtile to the Turkiſh creſcent, than even her victorious arms Scarcely had four years elapſed, when, after an armed negociation, a new treaty of pacification was agreed to by the reluctant ſultan, on the 21ſt of March 1789, in conſequence of which the Crimea was declared independent: an event not calculated to cloſe ancient jealouſies, but, on the contrary, to produce freſh diſſenſions, as it afforded an opening into the very heart of the Turkiſh empire, and a ready pretext for future interference. New claims and new conceſſions immediately followed. Ruſſia inſiſted on eſtabliſhing conſuls in the three provinces of Moldavia, Wallachia, and Beſſarabia, which ſhe was accordingly permitted to do by the treaty of 1781. Mortifying as this compliance was, it produced but a ſhort reſpite. The emperor Joſeph was now brought upon the political ſtage, and the Roman and Ruſſian eagles, after hovering over the carcaſs of the Turkiſh empire, and meditating to devour the whole, were at laſt content with a part of the prey. The empreſs, as it may be readily believed, was not inattentive to her own intereſts; and by the treaty of Conſtantinople, ſigned January 9. 1784, to Ruſſia was ceded the entire ſovereignty of the Crimea, which then received its ancient name of Taurica, the iſle of Taman, and part of Cuban.

It was now in the 58th year of her age, and the 25th of her reign, that Catherine may be ſaid to have attained the very ſummit of her wiſhes. There was no one who pretended to the throne, unleſs her ſon Paul Petrowitz, an amiable prince, who had attained his 33d year, without diſplaying the leaſt ſymptom of ambition, and who beſides was ſuperintended with the moſt watchful jealouſy. She had triumphed over a nation, ſuppoſed to be the *natural* enemy of Ruſſia, both by arms and negotiations, and ſhe dazzled her barbarous ſubjects with the blaze of her glory, for they were eager to forget her errors, in order to contemplate a grandeur which ſoothed their national vanity. Knowing the effect of ſplendour upon ignorance, ſhe uſhered in the year 1787 with a brilliant journey to Cherſon. Accompanied thither at once by a court and an army, with foreign ambaſſadors, an emperor and a king in her train, ſhe intended to have aſſumed the high-ſounding titles of Empreſs of the Eaſt, and Liberator of Greece. At Kiow, where ſhe remained during three months, ſhe was received under triumphal arches, and, having heard the petitions of the deputies from diſtant nations, and extended the walls of that city, ſhe inſcribed, with an arrogant anticipation, the following motto, in Greek characters, on the quarter next to Conſtantinople: "Through this gate lies the road to Byzantium."

Scarcely, however, had the empreſs, after viſiting Moſcow, returned to her capital, than the Turk thought proper to declare war. Her majeſty, long ſince prepared for an event which was far from being diſpleaſing, called forth the ſtipulated ſuccours of her ally the emperor; and the combined army under the Prince de Cobourg made itſelf maſter of Choczim, at the end of a ſiege of three months. Oczakow, after a ſtill more obſtinate reſiſtance, was taken by ſtorm, by the Ruſſians alone. A diverſion, however, was made by the king of Sweden, who, ſubſidized with Turkiſh gold, and directed by Pruſſian counſels, fought his own battles at the expence of his ally. But the exertions of this monarch were principally confined to the indeciſive naval actions of Stoogland, in which both parties claimed the victory, and this was ſoon after followed by a convention for peace.

Diſembarraſſed from an active, if not a powerful enemy, the empreſs no longer confined her conqueſts to the courſe of the Danube, but crowned the campaign with the capture of Iſmael, which was taken by ſtorm on the 22d of December. On this occaſion Suwarrow, one of her favourite generals, diſplayed a horrid mixture of courage and cruelty, and thus proved, to a demonſtration, that perſonal bravery is far from being incompatible with the deadlieſt revenge. Incenſed at the gallant reſiſtance of the Turks, like Cæſar, he ſnatched a ſtandard from a ſubaltern, and planted it with his own hand on the walls of the city; like Sylla, he doomed the vanquiſhed to experience a bloody proſcription, and upwards of 30,000 men, women, and children, if we are to credit the boaſtful account of the barbarians themſelves, periſhed by the ſword and bayonet of the unſparing Ruſſians.

Inſtead of regaining the Crimea, as had been expected by the ſultan, the fortreſs of Oczakow, and all the territories between the rivers Bog and Dneiſter, were aſſigned to the empreſs, who now found herſelf nearer to that Byzantium, on which ſhe had ſo eagerly fixed her eye, by a whole campaign, than at the commencement of hoſtilities.

Having concluded a final treaty of peace with the Turk, on the 9th of January 1792, by which the river Dneiſter became the boundary of the two empires, and was to be navigated by both, the empreſs had more time to apply her attention to European politics. Part of Poland had been diſmembered and partitioned during the year 1772, not only in contravention to the general rights of nations, but in direct oppoſition to the moſt ſolemn treaties on the part of Ruſſia, Pruſſia, and Auſtria. The revolution which took place in that ill-fated country on May 3. 1791, and which afforded the proſpect of a happy and ſtable government to the remains of the republic, was the ſignal of its annihilation. The imperial and royal ſpoilers ſeized this opportunity to fall once more in concert on their prey, which they forced to expire under their talons; and they have ſince cut it into ſhares, and attempted to disfigure it by new names, leſt it ſhould one day be reclaimed by the lawful owners. After this inſult to humanity, Staniſlaus, whom poſterity may acknowledge as an unfortunate, but ſurely not as a great king, was forced ſoon after to abdicate, and allowed to retire into obſcurity with his miſtreſs, his children, and a penſion.

Another great object had for ſome time engaged the attention of Catherine and her cabinet. This was the French revolution; an event pregnant with conſequences that involved the claims, or, more properly ſpeaking, the exiſtence of all the ſovereigns of Europe. With a treaſury nearly exhauſted by the war with the Ottoman Porte, which was not then terminated, and at a diſtance from the ſcene of action, the empreſs could not well engage in the conteſt; but ſhe readily entered into the coalition, and ſoon after ſubſidized her late enemy the king of Sweden; but that enterpriſing prince met his fate, on the night of the 16th of March 1792, by the hand of an aſſaſſin.

Notwithſtanding this ſiniſter event, the head of the Greek church, compaſſionating the fate of the pretended father of the Chriſtian world, promiſed to exert herſelf for the reſtoration of Avignon to the holy ſee. She alſo launched forth a menacing manifeſto againſt France, and prepared for a new war.

The empreſs has hitherto been contemplated in her public character. It may not be amiſs now to fix our eyes on the individual; to pay ſome attention to the ſex of the ſovereign, and, viewing majeſty as it were in an undreſs, behold the woman lurking behind the princeſs.

It might have been ſuppoſed, that in the neighbourhood of the Hyperborean regions, the paſſions, if not dormant would be at leaſt moderate, and that the men would conſequently be temperate, and the women chaſte. The contrary, however, is the caſe: and it is left to the philoſopher to determine, whether the double windows and heated rooms of St. Peterſburgh, added to an affectation of oriental manners, be not to the full as critical, in reſpect to female virtue, as the climate of Naples and Turin. Certain it is, however, that, during the reign of Catherine II. no remarkable increaſe of indecorum took place, and that any occaſional indiſcretions appear to have made but little impreſſion on the public mind.

Count Gregory Orloff, diſtinguiſhed in Ruſſia by the appellation of Gregorevitſch, was one of the handſomeſt men in the north. Gratitude and affection both conſpired to procure him a favourable reception at court: and from an obſcure condition he ſoon roſe to the higheſt offices of the ſtate, which he, in fact, governed. His opinion in the cabinet was liſtened to with deference, and he was inveſted with the ſupreme military command. Still higher honours awaited him. The empreſs-queen was ſolicited to grant him a diploma of prince of the empire; it was next in contemplation to decorate him with the titles of duke of Ingria and Carelia, and the chancellor Beſtucheff actually propoſed to the empreſs that he ſhould be admitted as the partner of her bed and throne. But this ſcheme was blaſted by the interference of Count Panin; who, not content with his own remonſtrances, invoked the interpoſition of Razumoffsky and Vorontzoff, and found means to divert Catherine from her purpoſe.

Soon after this the conduct of Orloff began to give diſſatisfaction: for he abſented himſelf from court; went but ſeldom to the palace; reſided principally in the country; and, being extremely addicted to hunting, dedicated whole weeks to the chaſe of the bear. Panin, who had frequently experienced his arrogance, deemed this a happy opportunity to procure his diſgrace. He accordingly introduced a young officer named Viſſenſky, who, being directed by the artful miniſter, behaved in ſuch a manner as to give reaſon to believe that he would ſoon reign uncontrolled. Pride, however, on this occaſion ſupplied the place of affection, and Orloff ſuddenly altering his conduct, his rival was diſmiſſed with ſuperb preſents, and inveſted with an employment that required his reſidence in a remote province.

A new favourite ſoon after made his appearance in the perſon of Vaſſiltſchikoff, a ſubaltern in the guards, and advantage was taken of the abſence of Orloff to introduce him at the hermitage. This officer was young and handſome; but nature, which had been laviſh to his perſon, ſeems to have been at no pains with his mind. He was immediately appointed chamberlain to the empreſs, enriched with ſplendid preſents, and treated with the moſt flattering attention. In the mean time Gregorevitſch, who had been appointed to treat with the Turkiſh plenipotentiaries relative to a peace, on hearing of this unexpected event, inſtantly returned to the capital from Fokſhiani, but was arreſted at the gates of Peterſburgh, and ſtripped of all his employments. He, however, experienced the imperial bounty, and received, as a recompence for his ſubmiſſion, the ſum of 100,000 rubles in hand, a penſion of 150,000 more, a magnificent ſervice of plate; and, to crown the whole, an eſtate, with 6000 peaſants upon it, was made over to him.

Vaſſiltſchikoff, during 22 months, enjoyed all the diſtinction belonging to the reigning favourite; but at the end of that period he alſo found occaſion to lament the inconſtancy of fortune. This young man had conducted himſelf with great prudence, for he had never abuſed his influence. He poſſeſſed none of that haughtineſs ſo common to upſtarts; and he did not appear eager to increaſe his own fortune, or to diminiſh that of his rivals. Such was his moderation, that, as his elevation excited no envy, ſo his diſgrace was unaccompanied by exultation. His faults are ſtill unknown; and moſt probably he had ceaſed to pleaſe. His retreat, however, was accompanied by every mark of reſpect; and as he repaired to Moſcow, the place of his deſtined exile, he received preſents on his journey, which might be ſtyled imperial on account of their magnificence.

No ſooner was this change made public than Orloff appeared once more on the ſcene, and was readmitted to all his former influence. Suppoſing Panin to be the cauſe of his late exile, he extorted a promiſe from his royal miſtreſs to diſmiſs him from his employments. Her aſſent was given with reluctance; and the prayers of the grand duke, who was too generous to ſuffer his preceptor to fall a prey to the ſuſpicions of a man he did not love, induced her to revoke her intentions.

In the mean time the manly air and elegant appearance of Potemkin made a great impreſſion on an illuſtrious perſonage. This officer had been bred in the guards; and, perceiving on that memorable day when the empreſs, mounted on a fine charger and dreſſed in regimentals, exhibited herſelf at the head of the troops, that ſhe had forgotten to place a plume in her hat, he ſnatched this decoration from his own, and preſented it to the new ſovereign. Neither this action, nor the grace with which it was performed, had eſcaped unnoticed; and the time was now arrived when his attachment was to receive an ample renumeration.

The poſt of favourite is almoſt peculiar to Ruſſia, and was during many years conſidered an *official employment*. Ever ſince 1730 the nation had been governed by women, except during the ſhort and unfortunate reign of Peter III. In fine, it ſeemed to be ſanctioned, if not by a fundamental law of the empire, at leaſt by preſcription; as four empreſſes had ſucceſſively conſecrated it by their practice, and the age of the laſt Elizabeth made it be conſidered in ſome meaſure as a mere appendage to imperial grandeur.

Potemkin ſoon grew giddy with ſucceſs, and his pride and preſumption keeping pace with his elevation, he accordingly expoſed himſelf to a number of diſagreeable events. Boaſting one day of the extent of his power in preſence of Count Alexis Orloff, the brother of his predeceſſor, he received a blow which deprived him of an eye; and Prince Gregory Orloff having requeſted his diſmiſſion, he was forced to repair to Smolenſk, at once the place of his nativity and exile. Such was his vexation, partly from the loſs of his eye, and partly from his diſgrace, that he actually entertained ſome ideas of turning monk; but a ſubmiſſive letter produced his recal; and from that moment he ſeemed to have dropped all thoughts of the cowl.

Ambition now appears to have taken complete poſſeſſion of the boſom of Potemkin; and this was amply gratified, for his influence ſoon extended to every department of the ſtate, and he himſelf, after procuring the diſmiſſion of Count Zachar Chernicheff, became vice-preſident at war, with a ſeat in the council. But his aſpiring hopes were not yet gratified, for he entertained ſtill higher expectations.

With a view to the accompliſhment of theſe, he affected to be once more ſeized with a fit of religion; and kept Lent with great ſtrictneſs, living upon roots and water during that holy ſeaſon. He alſo wearied all the ſaints in the Greek calendar with his prayers; went daily to confeſſion; and, having ſelected on this occaſion the ſame prieſt that afforded abſolution to a great perſonage, he beſought him to inform her, that his alarmed conſcience could no longer permit him to indulge in an intercourſe, which, by marriage alone, would ceaſe to become criminal.

This project, however, failed of ſucceſs; and, ſoon after the empreſs's return to Peterſburgh (for it was at Moſcow that it had been firſt conceived), a young man from the Ukraine, of the name of Zavadoffsky, was honoured with the imperial countenance, while the haughty Potemkin received the cuſtomary intimation, "that he muſt prepare to travel." Potemkin did not dare to diſobey, but he evaded the order; for, ſetting out in great form, he proceeded a few miles towards the place indicated for his exile, but returned in the courſe of next day, and placed himſelf in the evening exactly oppoſite to the empreſs as ſhe was about to ſit down to whiſt. Every one expected to behold ſome ſignal mark of the imperial diſpleaſure; but, on the contrary, Catherine, handing him a pack of cards, deſired the ex-favourite to cut in, obſerving that he had always been a fortunate player. His poſts, his honours, his influence, were all reſtored to him, and he now occupied a new ſituation about the perſon of her imperial majeſty, for he became her friend.

In the mean time the boſom of the humble Zavadoffsky began to catch the flame of ambition; and, as he was jealous of the grandeur of Potemkin, he aimed a deadly blow at his conſequence. But the miniſter at war, become wily in his turn, warded it off, and made it recoil on the head of his rival. Perceiving a handſome young Servian officer of huſſars, of the name of Zoritch, who had repaired to Peterſburgh in ſearch of promotion, he preſented him with a captain's commiſſion, and in a few days he was perceived behind the chair of the empreſs. A large eſtate, the rank of major-general, and an immenſe ſum of money, ſoon became the appanage of this fortunate youth; but the empreſs perceiving that he was ignorant, and being diſguſted at his want of accompliſhments, recommended, as he could ſpeak no language but that of the Ruſſian boors, that he ſhould be ſent abroad for improvement.

Fortune ſeems to have been in a playful mood when ſhe elevated Rimſky Korzakoff to the poſt of chamberlain, and ſucceſſor to the Servian. This man had actually been a ſerjeant in the guards; he was now declared aid-de-camp general to the empreſs, and preſented with the palace of Vaſſiltſchikoff.

He proved to be a vain upſtart, whoſe dreſs exhibited a profuſion of diamonds, and whoſe conduct was ſuch as could not fail to involve him in ruin. This ſpeedily occurred; for, being detected in a ſecret correſpondence with a lady, ſhe was baniſhed from court, and he was obliged to repair to Moſcow.

The ſame day that beheld his diſgrace, witneſſed the good fortune of Laſkoi, a Pole by deſcent, and an officer of the body-guards by profeſſion. The education of this young man had been neglected; but this defect was in ſome meaſure remedied by the zeal and attachment of an illuſtrious perſonage, who ſuperintended

tended his improvement ; and in a ſhort time he became as remarkable for the ſuperior elegance of his manners, as the graces of his perſon : but, while in the flower of his youth, and the very height of his favour, he was attacked by a mortal diſeaſe, which cut him off after a ſhort illneſs. He died in the arms of his miſtreſs, who was inconſolable on the occaſion, and refuſed to take any ſuſtenance during three whole days. A mauſoleum, the plan of which was ſketched out by an Engliſh artiſt, atteſted the reſpect of the empreſs, who burſt into tears on ſeeing it two years after. His fortune he had bequeathed to her imperial majeſty, but ſhe preſented it, with her accuſtomed generoſity, to the ſiſter of this handſome youth.

The next perſon who aſpired to the poſt of favourite was a young man educated in Scotland, and who had become a fellow of the Royal Society of London. This was prince Daſhkoff, ſon to the celebrated princeſs of the ſame name, who had participated in the memorable revolution that levelled Peter III. with the duſt. A lieutenant of the name of Yermoloff anticipated him, however, in this poſt, to which he was raiſed by the intereſt of Potemkin ; but, proving ungrateful to his benefactor, he was ſuddenly diſgraced, being replaced by Momonoff, who attended her imperial majeſty during her journey to the Crimea. He fell in love, however, with a lady of the court ; and no ſooner was the empreſs informed of this circumſtance, than ſhe inſiſted on his marrying her immediately ; after which they were ſent into exile at Moſcow.

Plato Zuboff, an officer of the horſe-guards, ſupplied his place. This aſpiring young man, not content with wealth and honours, affected public employments; and it is aſſerted that the idea of the ſecond diviſion of Poland originated with him. In a ſhort time he became omnipotent at Peterſburgh. He was decorated with the title of prince ; received the poſt of grand maſter of the artillery ; all the admirals, generals, and miniſters of the empire, were to be ſeen at his levee bending lowly before him ; and, if we are to believe the author of a work of ſome reputation, paying their compliments at the ſame time, in great form, to his favourite monkey.

Catherine hitherto had only afforded empty promiſes to the enemies of France ; but, at the inſtigation of Zuboff, ſhe now formed the deſign of giving effectual aſſiſtance to the confederated kings ; and, as a proof of her intentions, iſſued orders for a ſquadron of men of war to join the Engliſh fleet, and commanded a levy of 60,000 troops. She at the ſame time proſecuted a war on the frontiers of Perſia, where her army, under the command of a near relation of the grand maſter of the artillery, had experienced a moſt humiliating defeat ; and ſhe was now preparing to ſend freſh ſuccours to his aſſiſtance.

Such were the projects that occupied the mind of Catherine, the overthrow of the French republic, and the ſubjugation of the diſtant Perſians, when ſhe was ſmitten by the hand of death. This fortunate princeſs had hitherto enjoyed an almoſt uninterrupted ſtate of good health during the whole of her long reign. She was ſometimes, indeed, ſubject to a colic, and her legs were now and then obſerved to ſwell ; but neither of theſe ſymptoms were alarming.

On the morning of the 9th of November ſhe roſe at her uſual hour, and breakfaſted on coffee according to cuſtom. Some time after ſhe retired to her cloſet ; and her long abſence affording cauſe of ſuſpicion to her attendants, they entered the apartment, and found her lying ſpeechleſs. Dr Rogerſon, her phyſician, being ſent for, he treated her diſeaſe as an apoplexy, and conſiderable relief ſeemed to enſue after the application of the lancet. But the empreſs never entirely recovered her ſenſes ; and did not utter a ſingle word during the remainder of her life, which was prolonged to ten o'clock in the evening of November 10. 1797.

Thus, with her uſual good fortune, after a very ſhort illneſs, died Catherine II. empreſs of all the Ruſſias. During her youth ſhe had been extremely handſome, but ſhe got fat as ſhe increaſed in years ; ſhe, however, preſerved a certain air of gracefulneſs, intermingled with dignity, until the laſt moment of her life.

Her majeſty in perſon was not above the middle ſize, but, being well proportioned, and carrying her head high, ſhe appeared tall. Her forehead was open, her noſe aquiline, her mouth agreeable, and her chin, without being ugly, was rather long. Her hair, in which ſhe took great delight, was auburn, and her eye-brows dark and thick. Her eyes, according to ſome, were blue, while others inſiſt that they were of a brown hue. Upon the whole, her phyſiognomy was not deficient in expreſſion ; but ſhe had ſuch a command of her countenance, that no one could there diſcover the ſecrets of her heart.

Her imperial majeſty was accuſtomed, on great occaſions, to dreſs in a ſplendid manner, and to wear a profuſion of jewels. Being particularly fond of diamonds, ſhe poſſeſſed a prodigious number ; and one in particular was the largeſt that ever had been ſeen in Europe. Catherine, however, was accuſtomed in general to affect the ancient Ruſſian faſhions, for the moſt part wearing green, out of compliment to the nation. Her hair was powdered but ſlightly. On the other hand, her face was covered with rouge ; and as her imperial majeſty, like the ladies in the French court, wore it in proportion to her rank, it is not to be wondered if it was of a high colour.

The ſtricteſt temperance was regularly preſerved by Catherine, in a country, and at a court, where a little deviation would not have given occaſion to much ſcandal. A ſlight breakfaſt, a moderate dinner, and two or three glaſſes of wine (for ſhe never indulged in ſupper), conſtituted her uſual diet.

It is far more eaſy to deſcribe the empreſs than the woman. The acts of the former have now become hiſtory, but thoſe of the latter muſt be left to the pen of genius, that can analyze the ſprings of human action.

It muſt be confeſſed that both ſhe and the empire appear to have been frequently a prey to favouritiſm ; and this part of her conduct, by being connected with the happineſs of millions of her ſubjects, is highly cenſurable.

As a ſovereign ſhe ſtands conſpicuous. She increaſed the extent of Ruſſia, and added not only new countries, but new nations, to that mighty empire. As a conqueror, her victories were numerous and brilliant ; ſhe triumphed equally by ſea and by land, and had ſhe lived but ten years longer, might have realized the proud dream of her ambition, and beheld her grandſon Conſtantine ſitting on the throne of the Ottomans. Her merit as a legiſlator, too, is great; but ſhe would have been far more worthy of our admiration, had ſhe effected the generous idea of enfranchiſing all the peaſantry of her immenſe dominions.

She was the only ſovereign of Ruſſia who ever exhibited a taſte for letters. This was not all; ſhe was an author herſelf, and did not diſdain to compoſe little treatiſes for her grand-children, whoſe education ſhe ſuperintended.

For muſic ſhe alſo poſſeſſed an exquiſite reliſh, and brought Gabrielli, and a number of ſingers of great note, from Italy, allowing them liberal ſalaries, and treating them with great attention. Throughout the whole of her long reign Catherine alſo evinced a marked predilection for painting. In the midſt of a war with the Turks ſhe purchaſed pictures in Holland, to the amount of 60,000 rubles, all of which were loſt in conſequence of a ſhip's being wrecked on the coaſt of Finland. This, however, rather ſerved to ſtimulate her to freſh exertions, and her agents accordingly procured whatever was to be found in Italy worthy of notice. The Houghton collection from England was alſo transferred, by an act of her munificence, to the ſhores of the Baltic; and, while it added to her glory, diſgraced this nation in the eyes of foreigners.

Her conduct to learned men was truly worthy of a woman of genius. She was proud of the correſpondence and friendſhip of Voltaire; ſhe invited Diderot to her court, and lived with him, while there, in habits of the utmoſt familiarity; to D'Alembert ſhe looked up as to a ſuperior being, and endeavoured, although in vain, to ſeduce him to reſide at St Peterſburgh; but he poſſeſſed a haughty ſoul, was devoted to liberty, and would not conſent to degrade the mind of a freeman, by reſiding among a nation of ſlaves.

To the honour of Catherine, ſhe was extremely attentive to the education of her people, and inſtituted a prodigious number of ſchools for their inſtruction. To remove their prejudices againſt inoculation, ſhe herſelf ſubmitted to the operation, and thus hazarded her life for her nation. Amidſt the ſchemes of grandeur, the allurements of power, and the gratification of the paſſions, ſhe found leiſure to civilize and inſtruct her ſubjects; this added not a little to her glory, as it contributed to the benefit of ſo large a portion of the human race; but it will inſenſibly operate againſt a deſpotic government, by rendering the boors unfit for their chains, which they will ſome day break, perhaps, on the heads of the boyars, who at once enſlave and oppreſs them.

No woman could ſo eaſily forgive; and in this point of view her conduct muſt be allowed to have poſſeſſed a great ſhare of magnanimity. She generouſly pardoned old Munich and Godowitz, the one the counſellor, the other the favourite of Peter III. She even admitted the former of theſe into her confidence, and would have conferred honours and preferments on the latter; but he loved his late ſovereign, and with a noble ſcorn ſpurned at the proffered friendſhip of his ſucceſſor. To the miſtreſs of Peter III. although her own rival, ſhe granted her life, reſtored her fortune, and at length admitted her daughters to honourable ſituations at court.

No perſonage in our own times has attracted a greater ſhare of cenſure and eulogium than Catherine; and no woman in any age ever exhibited more of the maſculine greatneſs of one ſex, and the feminine weakneſs of another. As a female, ſhe appears at times the ſlave of paſſion, and the puppet of her courtiers; but while we behold her diminiſhing, in this point of view, into inſignificance, we look again, and contemplate the *ſovereign*, towering like an immenſe coloſſus, and with one foot placed on Cherſon, and another at Kamtſchatka, waving her iron ſceptre over the ſubject nations, and regulating the deſtiny of a large portion of mankind.

The frailties, however, of the woman will ſoon be forgotten, while the glory that encircles the brows of the legiſlator and conqueror will long continue to dazzle the eyes of an admiring world. The preſent age, however, ſhudders at the untimely fate of Peter and of Iwan, and poſterity will not eaſily pardon the degradation of Staniſlaus, the partition of Poland, and the maſſacres of Iſmailow and of Praga.

CATHERINE, Order of St, in modern hiſtory, belongs to ladies of the firſt quality in the Ruſſian court. It was inſtituted in 1714 by Catherine wife of Peter the Great, in memory of his ſignal eſcape from the Turks in 1711. The emblems of this order are a red croſs, ſupported by a figure of St Catherine, and faſtened to a ſcarlet ſtring edged with ſilver, on which are inſcribed the name of St Catherine, and the motto, *Pro fide et patria.*

CATHERLOUGH, a town of Ireland, in the county of Catherlough, and province of Leinſter; ſeated on the river Barrow, 16 miles N. E. of Kilkenny. W. Long. 7. 1. N. Lat. 52. 45.

CATHERLOUGH, a county of Ireland, about 28 miles in length, and eight in breadth; bounded on the eaſt by Wicklow and Wexford, on the weſt by Queen's county, on the north by Kildare, and on the ſouth and ſouth-weſt by Wexford. It contains 5600 houſes, 42 pariſhes, five baronies or boroughs, and ſends ſix members to parliament, viz. two for the county, two for Catherlough, and two for Old Leighlen.

CATHETER, in *Surgery*, a fiſtulous inſtrument, uſually made of ſilver, to be introduced into the bladder, in order to ſearch for the ſtone, or diſcharge the urine when ſuppreſſed. See SURGERY *Index*.

CATHETUS, in *Geometry*, a line or radius falling perpendicularly on another line or ſurface; thus the catheti of a right-angled triangle are the two ſides that include the right angle.

CATHETUS of Incidence, in *Catoptrics*, a right line drawn from a point of the object, perpendicular to the reflecting line.

CATHETUS of Reflection, or *of the Eye*, a right line drawn from the eye perpendicular to the reflecting plane.

CATHETUS of Obliquation, a right line drawn perpendicular to the ſpeculum, in the point of incidence or reflection.

CATHETUS, in *Architecture*, a perpendicular line, ſuppoſed to paſs through the middle of a cylindrical body, as a balluſter, column, &c.

CATHNESS. See CAITHNESS.

CATHOLIC, in a general ſenſe, denotes any thing that is univerſal or general.

Catholic Church. The riſe of hereſies induced the primitive Chriſtian church to aſſume to itſelf the appellation of *catholic*, being a characteriſtic to diſtinguiſh itſelf from all ſects, who, though they had party names, ſometimes ſheltered themſelves under the name of Chriſtians.

The Romiſh church diſtinguiſhes itſelf now by the name of *Catholic*, in oppoſition to all thoſe who have ſeparated from her communion, and whom ſhe conſiders as heretics and ſchiſmatics, and herſelf only as the true and Chriſtian church. In the ſtrict ſenſe of the word, there is no Catholic church in being, that is, no univerſal Chriſtian communion.

Catholic King, is a title which has been long hereditary to the king of Spain. Mariana pretends, that Reccarede firſt received this title after he had deſtroyed Arianiſm in his kingdom, and that it is found in the council of Toledo for the year 589. Vaſce aſcribes the origin of it to Alphonſus in 738. Some allege that it has been uſed only ſince the time of Ferdinand and Iſabella. Colombiere ſays, it was given them on occaſion of the expulſion of the Moors. The Bollandiſts pretend it had been borne by their predeceſſors the Viſigoth kings of Spain; and that Alexander VI. only renewed it to Ferdinand and Iſabella. Others ſay that Philip de Valois firſt bore the title; which was given him after his death by the eccleſiaſtics, on account of his favouring their intereſts.

In ſome epiſtles of the ancient popes, the title *catholic* is given to the kings of France and of Jeruſalem, as well as to ſeveral patriarchs and primates.

CATHOLICON, in *Pharmacy*, a kind of ſoft purgative electuary, ſo called, as being ſuppoſed an univerſal purger of all humours.

CATILINE, Lucius, a Roman of a noble family, who, having ſpent his whole fortune in debauchery, formed the deſign of oppreſſing his country, deſtroying the ſenate, ſeizing the public treaſury, ſetting Rome on fire, and uſurping a ſovereign power over his fellow-citizens. In order to ſucceed in this deſign, he drew ſome young noblemen into his plot; whom he prevailed upon, it is ſaid, to drink human blood as a pledge of their union. His conſpiracy, however, was diſcovered by the vigilance of Cicero, who was then conſul. Upon which, retiring from Rome, he put himſelf at the head of an army, with ſeveral of the conſpirators, and fought with incredible valour againſt Petreius, lieutenant to Antony, who was colleague with Cicero in the conſulſhip; but was defeated and killed in battle. See *(Hiſtory of)* Rome.—Salluſt has given an excellent hiſtory of this conſpiracy.

CATO, Marcus Portius, the cenſor, one of the greateſt men among the ancients, was born at Tuſculum in the year of Rome 519, about the 232d before Chriſt. He began to bear arms at 17; and, on all occaſions, ſhowed extraordinary courage. He was a man of great ſobriety, and reckoned no bodily exerciſe unworthy of him. He had but one horſe for himſelf and his baggage, and he looked after and dreſſed it himſelf. At his return from his campaigns, he betook himſelf to plough his ground; not that he was without ſlaves to do it, but it was his inclination. He dreſſed alſo like his ſlaves, ſat down at the ſame table with them, and partook of the ſame fare. He did not in the meanwhile neglect to cultivate his mind, eſpecially in regard to the art of ſpeaking; and he employed his talents, which were very great, in generouſly pleading cauſes in the neighbouring cities without fee or reward. Valerius Flaccus, who had a country ſeat near Cato, conceiving an eſteem for him, perſuaded him to come to Rome; where Cato, by his own merit, and the influence of ſo powerful a patron, was ſoon taken notice of, and promoted. He was firſt of all elected tribune of the ſoldiers for the province of Sicily; he was next made queſtor in Africa under Scipio. Having in this laſt office reproved him for his profuſeneſs to his ſoldiers, the general anſwered, that "he did not want ſo exact a queſtor, but would make war at what expence he pleaſed; nor was he to give an account to the Roman people of the money he ſpent, but of his enterpriſes, and the execution of them." Cato, provoked at this anſwer, left Sicily, and returned to Rome.

Afterwards Cato was made prætor, when he fulfilled the duties of his office with the ſtricteſt juſtice. He conquered Sardinia, governed with admirable moderation, and was created conſul. Being tribune in the war of Syria, he gave diſtinguiſhed proofs of his valour againſt Antiochus the Great; and at his return ſtood candidate for the office of cenſor. But the nobles, who not only envied him as a *new* man, but dreaded his ſeverity, ſet up againſt him ſeven powerful competitors. Valerius Flaccus, who had introduced him into public life, and had been his colleague in the conſulſhip, was a ninth candidate, and theſe two united their intereſts. On this occaſion Cato, far from employing ſoft words to the people, or giving hopes of gentleneſs or complaiſance in the execution of his office, loudly declared from the roſtra, with a threatening look and voice, "That the times required firm and vigorous magiſtrates to put a ſtop to that growing luxury which menaced the republic with ruin; cenſors who would cut up the evil by the roots, and reſtore the rigour of ancient diſcipline." It is to the honour of the people of Rome, that, notwithſtanding theſe terrible intimations, they preferred him to all his competitors, who courted them by promiſes of a mild and eaſy adminiſtration; the comitia alſo appointed his friend Valerius to be his colleague, without whom he had declared that he could not hope to compaſs the reformations he had in view. Cato's merit, upon the whole, was ſuperior to that of any of the great men who ſtood againſt him. He was temperate, brave, and indefatigable; frugal of the public money, and not to be corrupted. There is ſcarce any talent requiſite for public or private life which he had not received from nature, or acquired by induſtry. He was a great ſoldier, an able ſtateſman, an eloquent orator, a learned hiſtorian, and very knowing in rural affairs. Yet, with all theſe accompliſhments, he had very great faults. His ambition being poiſoned with envy, diſturbed both his own peace and that of the whole city as long as he lived Though he would not take bribes, he was unmerciful and unconſcionable in amaſſing wealth by all ſuch means as the law did not puniſh.

The firſt act of Cato in his new office, was naming his colleague to be prince of the ſenate: after which the cenſors ſtruck out of the liſt of the ſenators the names of ſeven perſons; among whom was Lucius the brother of T. Flaminius. Lucius, when conſul, and commanding in Gaul, had with his own hand murdered a Boian of diſtinction, a deſerter to the Romans; and he had committed this murder purely to gratify the curioſity of his pathic, a young Carthaginian, who longing to ſee ſomebody die a violent death, had reproached the general for bringing him away from Rome juſt when there was going to be a fight of gladiators. Titus Flaminius, full of indignation at the diſhonour done to his brother, brought the affair before the people; and inſiſted upon Cato's giving the reaſon of his proceeding. The cenſor related the ſtory; and when Lucius denied the fact, put him to his oath. The accuſed, refuſing to ſwear, was deemed guilty; and Cato's cenſure was approved. But no part of the cenſor's conduct ſeemed ſo cruel to the nobles and their wives as the taxes he laid upon luxury in all its branches; dreſs, houſehold furniture, women's toilets, chariots, ſlaves, and equipage. Theſe articles were all taxed at three *per cent.* of the real value. The people, however, in general, were pleaſed with his regulations; inſomuch that they ordered a ſtatue to be erected to his honour in the temple of *Health*, with an inſcription that mentioned nothing of his victories or triumphs, but imported only, that by his wiſe ordinances in his cenſorſhip he had reformed the manners of the republic. Plutarch relates, that before this, upon ſome of Cato's friends expreſſing their ſurpriſe, that when many perſons without merit or reputation had ſtatues, he had none; he anſwered, "I had much rather it ſhould be aſked why the people have not erected a ſtatue to Cato, than why they have." Cato was the occaſion of the third Punic war. Being diſpatched to Africa to terminate a difference between the Carthaginians and the king of Numidia, on his return to Rome he reported that Carthage was grown exceſſively rich and populous, and he warmly exhorted the ſenate to deſtroy a city and republic, during the exiſtence of which Rome could never be ſafe. Having brought from Africa ſome very large figs, he ſhowed them to the conſcript fathers in one of the lappets of his gown. "The country (ſays he) where this fine fruit grows is but a three days voyage from Rome." We are told, that from this time he never ſpoke in the ſenate upon any ſubject, without concluding with theſe words, "I am alſo of opinion, that Carthage ought to be deſtroyed." He judged, that for a people debauched by proſperity, nothing was more to be feared than a rival ſtate, always powerful, and now from its misfortunes grown wiſe and circumſpect. He held it neceſſary to remove all dangers that could be apprehended from *without*, when the republic had *within* ſo many diſtempers threatening her deſtruction.

From the cenſor, dignified and ſevere, the reader will not perhaps be diſpleaſed to turn his view upon Cato ſociable and relaxed. For we ſhould have a falſe notion of him, if we imagined that nothing but a ſad auſterity prevailed in his ſpeech and behaviour. On the contrary, he was extremely free; and often with his friends at table intermixed the converſation with lively diſcourſes and witty ſayings. Of theſe Plutarch has collected a pretty large number; we ſhall relate but one, and make uſe of Balzac's paraphraſe, and the preface with which he introduces it. "The very cenſors, though ſadneſs ſeemed to be one of the functions of their office, did not altogether lay aſide raillery. They were not always bent upon ſeverity; and the firſt Cato, that troubleſome and intolerable honeſt man, ceaſed ſometimes to be troubleſome and intolerable. He had ſome glimpſes of mirth, and ſome intervals of good humour. He dropped now and then ſome words that were not unpleaſant, and you may judge of the reſt by this. He had married a very handſome wife; and hiſtory tells us that ſhe was extremely afraid of the thunder, and loved her huſband well. Theſe two paſſions prompted her to the ſame thing; ſhe always pitched upon her huſband as a ſanctuary againſt thunder, and threw herſelf into his arms at the firſt noiſe ſhe fancied ſhe heard in the ſky. Cato, who was well pleaſed with the ſtorm, and very willing to be careſſed, could not conceal his joy. He revealed that domeſtic ſecret to his friends; and told them one day, ſpeaking of his wife, "that ſhe had found out a way to make him love bad weather; and that he never was ſo happy as when Jupiter was angry." It is worth obſerving, that this was during his cenſorſhip; when he degraded the ſenator Manlius, who would probably have been conſul the year after, only for giving a kiſs to his wife in the day-time, and in the preſence of his daughter.

Oeuvres d'diverſes, p. 49.

Cato died in the year of Rome 604, aged 85. He wrote ſeveral works. 1. A Roman Hiſtory. 2. Concerning the art of war. 3. Of Rhetoric. 4. A treatiſe of Huſbandry. Of theſe, the laſt only is extant.

CATO, *Marcus Portius*, commonly called Cato *Minor*, or Cato of *Utica*, was great-grandſon of Cato *the Cenſor*. It is ſaid, that from his infancy he diſcovered by his ſpeech, by his countenance, and even his childiſh ſports and recreations, an inflexibility of mind; for he would force himſelf to go through with whatever he had undertaken, though the taſk was ill-ſuited to his ſtrength. He was rough towards thoſe that flattered him, and quite untractable when threatened; was rarely ſeen to laugh, or even to ſmile; was not eaſily provoked to anger; but if once incenſed, hard to be pacified. Sylla having had a friendſhip for the father of Cato, ſent often for him and his brother, and talked familiarly with them. Cato, who was then about 14 years of age, ſeeing the heads of great men brought there, and obſerving the ſighs of thoſe that were preſent, aſked his preceptor, "Why does nobody kill this man?" Becauſe, ſaid the other, he is more feared than he is hated. The boy replied, Why then did you not give me a ſword when you brought me hither, that I might have ſtabbed him, and freed my country from this ſlavery?

He learned the principles of the Stoic philoſophy, which ſo well ſuited his character, under Antipater of Tyre, and applied himſelf diligently to the ſtudy of it. Eloquence he likewiſe ſtudied, as a neceſſary means to defend the cauſe of juſtice, and he made a very conſiderable proficiency in that ſcience. To increaſe his bodily ſtrength, he inured himſelf to ſuffer the extremes of heat and cold; and uſed to make journeys on foot and bare-headed in all ſeaſons. When he was ſick, patience and abſtinence were his only remedies: he ſhut himſelf up, and would ſee nobody till he was well. Though remarkably ſober in the beginning of his life, making it a rule to drink but once after ſupper, and then retire, he inſenſibly contracted a habit of drinking more freely, and of ſitting at table till morning. His friends endeavoured to excuſe this, by ſaying that the affairs of the public engroſſed his attention all the day; and that, being ambitious of knowledge, he paſſed the night in the converſation of philoſophers. Cæſar wrote, that Cato was once found dead drunk at the corner of a ſtreet, early in the morning, by a great number of people who were going to the levee of ſome great man; and that when, by uncovering his face, they perceived who it was, they bluſhed for ſhame: "You would have thought (added Cæſar), that Cato had found them drunk, not they him." Pliny obſerves, that by this reflection Cæſar praiſes his enemy at the ſame time that he blames him. And Seneca, his extravagant panegyriſt, ventures to aſſert, that it is eaſier to prove drunkenneſs to be a virtue, than Cato to be vicious. He affected ſingularity; and in things indifferent, to act directly contrary to the taſte and faſhions of the age. Magnanimity and conſtancy are generally aſcribed to him; and Seneca would fain make that haughtineſs and contempt for others which, in Cato, accompanied thoſe virtues, a matter of praiſe. Cato, ſays Seneca, having received a blow in the face, neither took revenge nor was angry; he did not even *pardon the affront*, but *denied that he had received it.* His virtue raiſed him ſo high, that injury could not reach him. He is reputed to have been chaſte in his youth. His firſt love was Lepida; but when the marriage was upon the point of being concluded, Metellus Scipio, to whom ſhe had been promiſed, interfered, and the preference was given to him. This affront extremely exaſperated our ſtoic. He was for going to law with Scipio; and when his friends had diverted him from that deſign, by ſhowing him the ridicule of it, he revenged himſelf by making verſes upon his rival. When this firſt flame ſubſided, he married Attilia the daughter of Serranus, had two children by her, and afterwards divorced her for her very indiſcreet conduct.

He ſerved as a volunteer under Gallus in the war of Spartacus; and when military rewards were offered him by the commander, he refuſed them, becauſe he thought he had no right to them. Some years after, he went a legionary tribune into Macedonia under the prætor Rubrius: in which ſtation he appeared, in his dreſs and during a march, more like a private ſoldier than an officer: but the dignity of his manners, the elevation of his ſentiments, and the ſuperiority of his views, ſet him far above thoſe who bore the titles of generals and proconſuls. It is ſaid, that Cato's deſign in all his behaviour was to engage the ſoldiers to the love of virtue; whoſe affections he engaged thereby to himſelf, without his having that in his intention. "For the ſincere love of virtue (adds Plutarch) implies an affection for the virtuous. Thoſe who praiſe the worthy without loving them, pay homage to their glory; but are neither admirers nor imitators of their virtues." When the time of his ſervice expired, and he was leaving the army, the ſoldiers were all in tears; ſo effectually had he gained their hearts by his condeſcending manners and ſharing in their labours. After his return home, he was choſen to the queſtorſhip; and had ſcarce entered on his charge, when he made a great reformation in the queſtor's office, and particularly with regard to the regiſters. Theſe regiſters, whoſe places were for life, and through whoſe hands paſſed inceſſantly all the public accounts, being to act under young magiſtrates unexperienced in buſineſs, aſſumed an air of importance; and, inſtead of aſking orders from the queſtors, pretended to direct and govern as if they themſelves were the queſtors. Cato reduced them to their proper ſphere.

One thing by which Cato extremely pleaſed the people, was his making the aſſaſſins to whom Sylla had given conſiderable rewards out of the treaſury for murdering the proſcribed, diſgorge their gains. Plutarch tells us, that Cato was ſo exact in diſcharging the duties of a ſenator, as to be always the firſt who came to the houſe, and the laſt who left it; and that he never quitted Rome during thoſe days when the ſenate was to ſit. Nor did he fail to be preſent at every aſſembly of the people, that he might awe thoſe who, by an ill-judged facility, beſtowed the public money in largeſſes, and frequently, through mere favour, granted remiſſion of debts due to the ſtate. At firſt his auſterity and ſtiffneſs diſpleaſed his colleagues; but afterwards they were glad to have his name to oppoſe to all the unjuſt ſolicitations, againſt which they would have found it difficult to defend themſelves. Cato very readily took upon him the taſk of refuſing.

Cato, to keep out a very bad man, put in for the tribunate. He ſided with Cicero againſt Catiline, and oppoſed Cæſar on that occaſion. His enemies ſent him to recover Cyprus, which Ptolemy had forfeited, thinking to hurt his reputation by ſo difficult an undertaking; yet none could find fault with his conduct.

Cato laboured to bring about an agreement between Cæſar and Pompey; but ſeeing it in vain, he ſided with the latter When Pompey was ſlain he fled to Utica; and being purſued by Cæſar, adviſed his friends to be gone, and throw themſelves on Cæſar's clemency. His ſon, however, remained with him; and Statilius, a young man, remarkable for his hatred to Cæſar.

The evening before the execution of the purpoſe he had formed with regard to himſelf, after bathing, he ſupped with his friends and the magiſtrates of the city. They ſat late at table, and the converſation was lively. The diſcourſe falling upon this maxim of the Stoics, that "the wiſe man alone is free, and that the vicious are ſlaves;" Demetrius, who was a Peripatetic, undertook to confute it from the maxims of his ſchool. Cato, in anſwer, treated the matter very amply; and with ſo much earneſtneſs and vehemence of voice, that he betrayed himſelf, and confirmed the ſuſpicions of his friends that he deſigned to kill himſelf. When he had done ſpeaking, a melancholy ſilence enſued; and Cato perceiving it, turned the diſcourſe to the preſent ſituation of affairs, expreſſing his concern for thoſe who had been obliged to put to ſea, as well as for thoſe who had determined to make their eſcape by land, and had a dry and ſandy deſert to paſs. After ſupper, the company being diſmiſſed, he walked for ſome time with a few friends, and gave his orders to the officers of the guard: and going into his chamber, he embraced his ſon and his friends with more than uſual tenderneſs, which farther confirmed the ſuſpicions of the reſolution he had taken. Then laying himſelf down on his bed, he took up Plato's Dialogue on the Immortality of the Soul. Having read for ſome time, he looked up, and miſſing his ſword, which his ſon had removed while he was at ſupper, he called a ſlave, and aſked who had taken it away; and receiving no pertinent anſwer, he reſumed his reading. Some time after, he aſked again for his ſword; and, without ſhowing any impatience, ordered it to be brought to him: but, having read out the book, and finding nobody had brought him his ſword, he called for all his ſervants, fell into a rage, and ſtruck one of them on the mouth with ſo much violence that he very much hurt his own hand, crying out in a paſſionate manner, "What! do my own ſon and family conſpire to betray me, and deliver me up naked and unarmed to the enemy?" Immediately his ſon and friends ruſhed into the room; and began to lament, and to beſeech him to change his reſolution. Cato raiſing himſelf, and looking fiercely at them, "How long is it," ſaid he, "ſince I have loſt my ſenſes, and my ſon is become my keeper? Brave and generous ſon, why do you not bind your father's hands, that when Cæſar comes, he may find me unable to defend myſelf? Do you imagine that without a ſword I cannot end my life? Cannot I deſtroy myſelf, by holding my breath for ſome moments, or by ſtriking my head againſt the wall?" His ſon anſwered with his tears, and retired. Apollonides and Demetrius remained with him; and to them he addreſſed himſelf in the following words: "Is it to watch over me that ye ſit ſilent here? Do you pretend to force a man of my years to live? or can you bring any reaſon to prove, that it is not baſe and unworthy of Cato to beg his ſafety of an enemy? or why do you not perſuade me to unlearn what I have been taught, that, rejecting all the opinions I have hitherto defended, I may now, by Cæſar's means, grow wiſer, and be yet more obliged to him than for life alone? Not that I have determined any thing concerning myſelf; but I would have it in my power to perform what I ſhall think fit to reſolve upon: and I ſhall not fail to aſk your counſel, when I have occaſion to act up to the principles which your philoſophy teaches. Go tell my ſon, that he ſhould not compel his father to what he cannot perſuade him." They withdrew, and the ſword was brought by a young ſlave. Cato drew it, and finding the point to be ſharp; "Now, (ſaid he), I am my own maſter:" And, laying it down, he took up his book again, which it is reported he read twice over. After this he ſlept ſo ſoundly that he was heard to ſnore by thoſe who were near him. About midnight he called two of his freedmen, Cleanthes his phyſician, and Butas whom he chiefly employed in the management of his affairs. The laſt he ſent to the port, to ſee whether all the Romans were gone; to the phyſician he gave his hand to be dreſſed, which was ſwelled by the blow he had given his ſlave. This being an intimation that he intended to live, gave great joy to his family. Butas ſoon returned, and brought word that they were all gone except Craſſus, who had ſtaid upon ſome buſineſs, but was juſt ready to depart. He added, that the wind was high and the ſea rough. Theſe words drew a ſigh from Cato. He ſent Butas again to the port, to know whether there might not be ſome one, who, in the hurry of embarkation, had forgot ſome neceſſary proviſions, and had been obliged to put back to Utica. It was now break of day, and Cato ſlept yet a little more, till Butas returned to tell him, that all was perfectly quiet. He then ordered him to ſhut his door; and he flung himſelf upon his bed, as if he meant to finiſh his night's reſt; but immediately he took his ſword, and ſtabbed himſelf a little below his cheſt; yet not being able to uſe his hand ſo well by reaſon of the ſwelling, the blow did not kill him. It threw him into a convulſion, in which he fell from his bed, and overturned a table near it. The noiſe gave the alarm; and his ſon and the reſt of the family, entering the room, found him weltering in his blood, and his bowels half out of his body. The ſurgeon, upon examination, found that his bowels were not cut; and was preparing to replace them and bind up the wound, when Cato, recovering his ſenſes, thruſt the ſurgeon from him, and, tearing out his bowels, immediately expired, in the 48th year of his age.

By this raſh act, independent of all moral or religious conſiderations, he carried his patriotiſm to the higheſt degree of political phrenſy: for Cato, dead, could be of no uſe to his country: but had be preſerved his life, his counſel might have moderated Cæſar's ambition, and (as Monteſquieu obſerves) have given a different turn to public affairs.

CATOCHE, or Catochus, a diſeaſe, by which the patient is rendered in an inſtant as immoveable as a ſtatue, without either ſenſe or motion, and continues in the ſame poſture he was in at the moment of his being ſeized. See Medicine *Index*.

CATOPTRICS.

CATOPTRICS is that part of optics which explains the properties of reflected light, and particularly that which is reflected from mirrors.

As this and the other branches of Optics will be fully treated under the collective word, we ſhall, in the preſent article, 1ſt, Juſt give a ſummary of the principles of the branch, in a few plain aphoriſms, with ſome preliminary definitions; and, 2dly, Inſert a ſet of entertaining experiments founded upon them.

Sect. I. *Definitions.*

1. Every poliſhed body that reflects the rays of light is called a mirror, whether its ſurface be plane, ſpherical, conical, cylindric, or of any other form whatever. 1. Definitions.

2. Of mirrors there are three principally uſed in optical experiments: The plane mirror, GHI, (fig. 1.); Plate CXXXVI.

1.); the ſpherical convex mirror, GHI, (fig. 2.); and the ſpherical concave mirror, GHI, (fig. 3.)

3. The point K, (fig. 2, 3.) round which the reflecting ſurface of a ſpherical mirror is deſcribed, is called its centre. The line KH, drawn from its centre perpendicular to its two ſurfaces, is the axis of the mirror; and the point H, to which that line is drawn, is its vortex.

4. The diſtance between the lines AG and BG, (fig. 1.) is called the angle of incidence, and the diſtance between BG and CG is the angle of reflection.

SECT. II. *Aphoriſms.*

2
I. In a plane mirror.

1. The image DF, (fig. 1.) will appear as far behind the mirror as the object AC is before it.

2. The image will appear of the ſame ſize, and in the ſame poſition as the object.

3. Every ſuch mirror will reflect the image of an object of twice its own length and breadth.

4. If the object be an opaque body, and its rays fall on the mirror nearly in direct lines, there will be only one image viſible, which will be reflected by the inner ſurface of the glaſs. But,

5. If the object be a luminous body, and its rays fall very obliquely on the mirror, there will appear to an eye, placed in a proper poſition, ſeveral images; the firſt of which reflected from the outer ſurface of the glaſs, will not be ſo bright as the ſecond, reflected from the inner ſurface. The following images, that are produced by the repeated reflections of the rays between the two ſurfaces of the glaſs, will be in proportion leſs vivid, to the eighth or tenth, which will be ſcarce viſible.

3
II. In a ſpherical convex mirror.

1. The image DF, (fig. 2.), will always appear behind it.

2. The image will be in the ſame poſition as the object.

3. It will be leſs than the object.

4. It will be curved, but not, as the mirror, ſpherical.

5. Parallel rays falling on this mirror will have the focus or image at half the diſtance of the centre K from the mirror.

6. In converging rays, the diſtance of the object muſt be equal to half the diſtance of the centre, to make the image appear behind the mirror.

7. Diverging rays will have their image at leſs than half the diſtance of the centre. If the object be placed in the centre of the mirror, its image will appear at one eighth of that diſtance behind it.

III. In a ſpherical concave mirror.

1. That point where the image appears of the ſame dimenſions as the object, is the centre of that mirror.

2. Parallel rays will have their focus at one half the diſtance of the centre.

3. Converging rays will form an image before the mirror.

4. In diverging rays, if the object be at leſs than one-half the diſtance of the centre, the image will be behind the mirror, erect, curved, and magnified, as DEF, (fig. 3.) but if the diſtance of the object be greater, the image will be before the mirror, inverted and diminiſhed, as DEF, (fig. 4.)

5. The ſun's rays falling on a concave mirror, and being parallel, will be collected in a focus at half the diſtance of its centre, where their heat will be augmented in proportion of the ſurface of the mirror to that of the focal ſpot.

6. If a luminous body be placed in the focus of a concave mirror, its rays being reflected in parallel lines, will ſtrongly enlighten a ſpace of the ſame dimenſion with the mirror, at a great diſtance. If the luminous object be placed nearer than the focus, its rays will diverge, and conſequently enlighten a larger ſpace. It is on this principle that reverberators are conſtructed.

IV. In all plane and ſpherical mirrors the angle of incidence is equal to the angle of reflection.

SECT. III. *Entertaining Experiments.*

5
I. Catoptrical illuſions.

I. Of all our ſenſes the ſight is certainly ſubject to the greateſt illuſion. The various writers on optics have deſcribed a great number of inſtances in which it deceives us, and have conſtantly endeavoured to inveſtigate the cauſes, to explain their effects, and to reconcile appearance with reality. We every day diſcover new phenomena, and doubtleſs many more are reſerved for poſterity. It frequently happens, moreover, that a diſcovery which at firſt ſeemed of little conſequence has led to matters of the higheſt importance.

Take a glaſs bottle A (fig. 14.) and fill it with water to the point B; leave the upper part BC empty, and cork it in the common manner. Place this bottle oppoſite a concave mirror, and beyond its focus, that it may appear reverſed, and before the mirror (ſee Sect. II. aph. 3. 4. of a ſpher. concave mirror,) place yourſelf ſtill further diſtant from the bottle, and it will appear to you in the ſituation, *a*, *b*, *c*, (fig. 15.)

Now it is remarkable in this apparent bottle, that the water, which, according to all the laws of catoptrics, and all the experiments made on other objects, ſhould appear at *a b*, appears on the contrary at *b c*, and conſequently the part *a b* appears empty.

If the bottle be inverted and placed before the mirror (as in fig. 16.), its image will appear in its natural erect poſition; and the water, which is in reality at BC, will appear at *a b*.

If while the bottle is inverted it be uncorked, and the water run gently out, it will appear, that while the part BC is emptying, that of *a b* in the image is filling; and what is likewiſe very remarkable, as ſoon as the bottle is empty the illuſion ceaſes, the image alſo appearing entirely empty. If the bottle likewiſe be quite full there is no illuſion.

If while the bottle is held inverted, and partly empty, ſome drops of water fall from the bottom A towards BC, it ſeems in the image as if there were formed at the bottom of that part *a b*, bubbles of air that roſe from *a* to *b*; which is the part that ſeems full of water. All theſe phenomena conſtantly appear.

The remarkable circumſtances in this experiment are, firſt, not only to ſee an object where it is not, but alſo where the image is not; and ſecondly, that of two objects which are really in its ſame place, as the ſurface at one place, and the other at another; and to ſee the bottle in the place of its image, and the water where neither it nor its image are.

II. Conſtruct a box AB, of about a foot long, eight

6
II. Appearance of a boundleſs viſta, fig. 5.

inches wide, and ſix high; or what other dimenſions you ſhall think fit, provided it does not greatly vary from theſe proportions.

On the inſide of this box, and againſt each of its oppoſite ends A and B, place a mirror of the ſame ſize. Take off the quickſilver from the mirror that you place at B, for about an inch and a half, at the part C, where you are to make a hole in the box of the ſame ſize, by which you may eaſily view its inſide. Cover the top of the box with a frame, in which muſt be placed a tranſparent glaſs, covered with gauze, on the ſide next the inner part of the box. Let there be two grooves at the parts E and F to receive the two painted ſcenes hereafter mentioned. On two pieces of cut paſteboard let there be ſkilfully painted on both ſides (ſee fig. 6. and 7.) any ſubject you think proper; as woods, gardens, bowers, colonnades, &c. and on two other paſteboards, the ſame ſubjects on one ſide only; obſerving that there ought to be on one of them ſome object relative to the ſubject placed at A, that the mirror placed at D may not reflect the hole at C on the oppoſite ſide.

Place the two boards painted on both ſides in the grooves E and F; and thoſe that are painted on one ſide only againſt the oppoſite mirrors C and D; and then cover the box with its tranſparent top. This box ſhould be placed in a ſtrong light to have a good effect.

When the eye is placed at C, and views the objects on the inſide of the box, of which ſome, as we have ſaid, are painted on both ſides, they are ſucceſſively reflected from one mirror to the other; and if, for example, the painting conſiſts of trees, they will appear like a very long viſta, of which the eye cannot diſcern the end: for each of the mirrors repeating the objects, continually more faintly, contribute greatly to augment the illuſion.

7
III. Of a fortification of immenſe extent, fig. 8.

III. Take a ſquare box ABCD, of about ſix inches long, and twelve high; cover the inſide of it with four plane mirrors, which muſt be placed perpendicular to the bottom of the box CHFD.

Place certain objects in relief on the bottom of this box; ſuppoſe, for example, a piece of fortification, (as fig. 9.) with tents, ſoldiers, &c, or any other ſubject that you judge will produce an agreeable effect by its diſpoſition when repeatedly reflected by the mirrors.

On the top of this box place a frame of glaſs, in form of the bottom part of a pyramid, whoſe baſe AGEB is equal to the ſize of the box: its top ILN muſt form a ſquare of ſix inches, and ſhould not be more than four or five inches higher than the box. Cover the four ſides of this frame with a gauze, that the inſide may not be viſible but at the top ILN, which ſhould be covered with a tranſparent glaſs.

When you look into this box through the glaſs LN, the mirrors that are diametrically oppoſite each other, mutually reflecting the figures encloſed, the eye beholds a boundleſs extent, completely covered with theſe objects; and if they are properly diſpoſed, the illuſion will occaſion no ſmall ſurpriſe, and afford great entertainment.

Note, The nearer the opening ILN is to the top of the box, the greater will be the apparent extent of the ſubject. The ſame will happen if the four mirrors placed on the ſides of the box be more elevated. The objects, by either of theſe diſpoſitions, will appear to be repeated nine, twenty-five, forty-nine times, &c. by taking always the ſquare of the odd numbers of the arithmetical progreſſion 3, 5, 7, 9, &c. as is very eaſy to conceive, if we remember that the ſubject encloſed in the box is always in the centre of a ſquare, compoſed of ſeveral others, equal to that which forms the bottom of the box.

Other pieces of the ſame kind (that is, viewed from above) may be contrived, in which mirrors may be placed perpendicular on a triangular, pentagon, or hexagon (that is, a three, five, or ſix ſided) plane. All theſe different diſpoſitions, properly directed, as well with regard to the choice as poſition of the objects, will conſtantly produce very remarkable and pleaſing illuſions.

If inſtead of placing the mirrors perpendicular, they were to incline equally, ſo as to form part of a reverſed pyramid, the ſubject placed in the box would then have the appearance of a very extenſive globular or many-ſided figure.

8
IV. Surpriſing multiplication of objects, fig. 10.

IV. On the hexagonal or ſix-ſided plane ABCDEF draw ſix ſemi diameters GA, GB, GC, GD, GE, GF; and on each of theſe place perpendicularly two plane mirrors, which muſt join exactly at the centre G, and which placed back to back muſt be as thin as poſſible. Decorate the exterior boundary of this piece (which is at the extremity of the angles of the hexagon) with ſix columns, that at the ſame time ſerve to ſupport the mirrors, by grooves formed on their inner ſides. (See the profile H). Add to theſe columns their entablatures, and cover the edifice in ſuch manner as you ſhall think proper.

In each one of theſe ſix triangular ſpaces, contained between two mirrors, place little figures of paſteboard, in relief, repreſenting ſuch objects as when ſeen in a hexagonal form will produce an agreeable effect. To theſe add ſmall figures of enamel; and take particular care to conceal, by ſome object that has relation to the ſubject, the place where the mirrors join, which, as we have ſaid before, all meet in the common centre G.

When you look into any one of the ſix openings of this palace, the objects there contained being repeated ſix times, will ſeem entirely to fill up the whole of the building. This illuſion will appear very remarkable; eſpecially if the objects made choice of are properly adapted to the effect that is to be produced by the mirrors.

Note, If you place between two of theſe mirrors part of a fortification, as a curtain and two demibaſtions, you will ſee an entire citadel, with ſix baſtions. Or if you place part of a ball-room, ornamented with chandeliers and figures in enamel, all thoſe objects being here multiplied, will afford a very pleaſing proſpect.

9
V. Opaque bodies ſeemingly rendered tranſparent, fig. 11.

V. Within the caſe ABCD, place your mirrors, O, P, Q, R, ſo diſpoſed that they may each of them make an angle of forty-five degrees, that is, that they may be half way inclined from the perpendicular, as in the figure. In each of the two extremities AB, make a circular overture, in one of which fix the tube

GL, in the other the tube MF, and obſerve that in each of theſe is to be inſerted another tube, as H and I (A).

Furniſh the firſt of theſe tubes with an object-glaſs at G, and a concave eye-glaſs at F. You are to obſerve, that in regulating the focus of theſe glaſſes, with regard to the length of the tube, you are to ſuppoſe it equal to the line G, or viſual pointed ray, which entering at the overture G, is reflected by the four mirrors, and goes out at the other aperture F, where the ocular glaſs is placed. Put any glaſs you will into the two ends of the moveable tubes H and I; and, laſtly, place the machine on a ſtand E, moveable at the point S, that it may be elevated or depreſſed at pleaſure.

When the eye is placed at F, and you look through the tube, the rays of light that proceed from the object T, paſſing through the glaſs G, are ſucceſſively reflected by the mirrors O, P, Q, and R, to the eye at F, and there paint the object T, in its proper ſituation, and theſe rays appear to proceed directly from that object.

The two moveable tubes H and I, at the extremities of each of which a glaſs is placed, ſerve only the more to diſguiſe the illuſion, for they have no communication with the interior part of the machine. This inſtrument being moveable on the ſtand E, may be directed to any object; and if furniſhed with proper glaſſes will anſwer the purpoſe of a common perſpective.

The two moveable tubes H and I being brought together, the machine is directed toward any object, and deſiring a perſon to look at the end F, you aſk him if he ſees diſtinctly that object. You then ſeparate the two moveable tubes, and leaving a ſpace between them ſufficient to place your hand, or any other ſolid body; you tell him that the machine has the power of making objects viſible through the moſt opaque body; and as a proof you deſire him then to look at the ſame object, when, to his great ſurpriſe, he will ſee it as diſtinct as when there was no ſolid body placed between the tubes.

Note, This experiment is the more extraordinary, as it is very difficult to conceive how the effect is produced. The two arms of the caſe appearing to be made to ſupport the perſpective glaſs; and to whatever object it is directed, the effect is ſtill the ſame.

10
VI. VII.
The magician's mirror, fig. 12

VI. In the partition AB, make two apertures, CD, and EF, of a foot high, and ten inches wide, and about a foot diſtant from each other. Let them be at the common height of a man's head; and in each of them place a tranſparent glaſs, ſurrounded with a frame, like a common mirror.

Behind this partition place two mirrors H and I, inclined to it in an angle of forty-five degrees; that is, half way between a line drawn perpendicular to the ground and its ſurface; let them be both 18 inches ſquare: let all the ſpace between them be incloſed by boards or paſteboard painted black, and well cloſed, that no light may enter: let there be alſo two curtains to cover them, which may be drawn aſide at pleaſure.

When a perſon looks into one of theſe ſuppoſed mirrors, inſtead of ſeeing his own face, he will perceive the object that is in front of the other; ſo that if two perſons preſent themſelves at the ſame time before theſe mirrors, inſtead of each one ſeeing himſelf, they will reciprocally ſee each other.

Note, There ſhould be a ſconce with a candle placed on each ſide of the two glaſſes in the wainſcot, to enlighten the faces of the perſons who look in them, otherwiſe this experiment will have no remarkable effect.

This experiment may be conſiderably improved by placing the two glaſſes in the partition in adjoining rooms, and a number of perſons being previouſly placed in one room, when a ſtranger enters the other, you may tell him his face is dirty; and deſire him to look in the glaſs, which he will naturally do; and on ſeeing a ſtrange face he will draw back; but returning to it, and ſeeing another, another, and another, like the phantom kings in Macbeth, what his ſurpriſe will be is more eaſy to conceive than expreſs. After this, a real mirror may be privately let down on the back of the glaſs; and if he can be prevailed to look in it once more, he will then, to his further aſtoniſhment, ſee his own face; and may be told, perhaps perſuaded, that all he thought he ſaw before was the mere effect of imagination.

How many tricks, leſs artful than this, have paſſed in former times for ſorcery, and paſs at this time in ſome countries for apparitions!

Note, When a man looks in a mirror that is placed perpendicular to another, his face will appear entirely deformed. If the mirror be a little inclined, ſo as to make an angle of 80 degrees (that is, one-ninth part from the perpendicular), he will then ſee all the parts of his face, except the noſe and forehead. If it be inclined to 60 degrees (that is, one-third part), he will appear with three noſes and ſix eyes: in ſhort, the apparent deformity will vary at each degree of inclination; and when the glaſs comes to 45 degrees (that is, half way down), the face will vaniſh. If, inſtead of placing the two mirrors in this ſituation, they are ſo diſpoſed that their junction may be vertical, their different inclinations will produce other effects; as the ſituation of the object relative to theſe mirrors is quite different. The effects of theſe mirrors, though remarkable enough, occaſions but little ſurpriſe, as there is no method of concealing the cauſe by which they are produced.

VII. Make a box of wood, of a cubical figure, ABCD, of about 15 inches every way. Let it be fixed to the pedeſtal P, at the uſual height of a man's head. In each ſide of this box, let there be an open- 11 Fig 13.

(A) Theſe four tubes muſt terminate in the ſubſtance of the caſe, and not enter the inſide, that they may not hinder the effect of the mirrors. The fourfold reflection of the rays of light from the mirrors, darkens in ſome degree the brightneſs of the object; ſome light is alſo loſt by the magnifying power of the perſpective. If, therefore, inſtead of the object-glaſs at G, and concave eye glaſs at F, plain glaſſes were ſubſtituted, the magnifying power of the perſpective will be taken away, and the object appear brighter.

ing of an oval form, of ten inches high, and ſeven wide.

In this box place two mirrors A, D, with their backs againſt each other; let them croſs the box in a diagonal line, and in a vertical poſition. Decorate the openings in the ſides of this box with four oval frames and tranſparent glaſſes, and cover each of them with a curtain, ſo contrived that they may all draw up together.

Place four perſons in front of the four ſides, and at equal diſtances from the box, and then draw up the curtains that they may ſee themſelves in the mirrors; when each of them, inſtead of his own figure, will ſee that of the perſon who is next to him, and who, at the ſame time, will ſeem to him to be placed on the oppoſite ſide. Their confuſion will be the greater, as it will be very difficult for them to diſcover the mirrors concealed in the box. The reaſon of this phenomenon is evident; for though the rays of light may be turned aſide by a mirror, yet, as we have before ſaid, they always appear to proceed in right lines.

12 VIII. The perſpective mirror, fig 17.

VIII. Provide a box ABCD of about two feet long, 15 inches wide, and 12 inches high. At the end AC place a concave mirror, the focus of whoſe parallel rays is at 18 inches from the reflecting ſurface. At IL place a paſteboard blacked, in which a hole is cut ſufficiently large to ſee on the mirror H the object placed at BEFD.

Cover the top of the box, from A to I, cloſe, that the mirror H may be entirely darkened. The other part IB muſt be covered with a glaſs, under which is placed a gauze.

Make an aperture at G, near the top of the ſide EB; beneath which, on the inſide, place, in ſucceſſion, paintings of different ſubjects, as viſtas, landſcapes, &c. ſo that they may be in front of the mirror H. Let the box be ſo placed that the object may be ſtrongly illuminated by the ſun, or by wax lights placed under the encloſed part of the box AI.

By this ſimple conſtruction the objects placed at GD will be thrown into their natural perſpective; and if the ſubjects be properly choſen, the appearance will be altogether as pleaſing as in optical machines of a much more complicated form.

Note, A glaſs mirror ſhould be always here uſed, as thoſe of metal do not repreſent the objects with equal vivacity, and are beſide ſubject to tarniſh. It is alſo neceſſary that the box be ſufficiently large, that you may not be obliged to uſe a mirror whoſe focus is too ſhort; for in that caſe, the right lines near the border of the picture will appear bent in the mirror, which will have a diſagreeable effect, and cannot be avoided.

13 IX. To ſet fire to a combuſtible body by the reflection of two concave mirrors, fig. 18.

IX. The rays of a luminous body placed in the focus of a concave mirror being reflected in parallel lines, if a ſecond mirror be placed diametrically oppoſite the firſt, it will, by collecting thoſe rays in its focus, ſet fire to a combuſtible body.

Place two concave mirrors, A and B, at about 12 or 15 feet diſtance from each other, and let the axis of each of them be in the ſame line. In the focus C of one of them, place a live coal, and in the focus D of the other ſome gunpowder. With a pair of double bellows, which make a continual blaſt, keep conſtantly blowing the coal, and notwithſtanding the diſtance between them, the powder will preſently take fire.

It is not neceſſary that theſe mirrors be of metal or braſs, thoſe made of wood or paſteboard gilded will produce the exploſion, which has ſometimes taken effect at the diſtance of 50 feet, when mirrors of 18 inches, or two feet diameter, have been uſed.

This experiment ſucceeds with more difficulty at great diſtances; which may proceed from the moiſture in a large quantity of air. It would doubtleſs take effect more readily, if a tin tube, of an equal diameter with the mirrors, were to be placed between them.

14 The real apparition, fig. 19.

X. Behind the partition AB, place, in a poſition ſomething oblique, the concave mirror EF, which muſt be at leaſt ten inches in diameter, and its diſtance from the partition equal to three fourths of the diſtance of its centre.

In the partition make an opening of ſeven or eight inches, either ſquare or circular: it muſt face the mirror, and be of the ſame height with it. Behind this partition place a ſtrong light, ſo diſpoſed that it may not be ſeen at the opening, and may illumine an object placed at C, without throwing any light on the mirror.

Beneath the aperture in the partition place the object C, that you intend ſhall appear on the outſide of the partition, in an inverted poſition; and which we will ſuppoſe to be a flower. Before the partition, and beneath the aperture, place a little flowerpot D, the top of which ſhould be even with the bottom of the aperture, that the eye, placed at G, may ſee the flower in the ſame poſition as if its ſtalk came out of the pot.

Take care to paint the ſpace between the back part of the partition and the mirror black, to prevent any reflections of light from being thrown on the mirror; in a word, ſo diſpoſe the whole that it may be as little enlightened as poſſible.

When a perſon is placed at the point G, he will perceive the flower that is behind the partition, at the top of the pot at D; but on putting out his hand to pluck it, he will find that he attempts to graſp a ſhadow.

If in the opening of the partition a large double convex lens of a ſhort focus be placed, or, which is not quite ſo well, a bottle of clear water, the image of the flower reflected thereon will appear much more vivid and diſtinct.

Obſervations.

The phenomena that may be produced by means of concave mirrors are highly curious and aſtoniſhing. By their aid, ſpectres of various kinds may be exhibited. Suppoſe, for example, a perſon with a drawn ſword places himſelf before a large concave mirror, but farther from it than its focus; he will then ſee an inverted image of himſelf in the air, between him and the mirror, of a leſs ſize than himſelf. If he ſteadily preſent the ſword towards the centre of the mirror, an image of the ſword will come out therefrom towards the ſword in his hand, point to point, as it were to fence with him; and by his puſhing the ſword nearer, the image will appear to come nearer him, and almoſt to touch his breaſt, having a ſtriking effect upon him. If the mirror be turned 45 degrees, or one-eighth round,

Fig. 1.

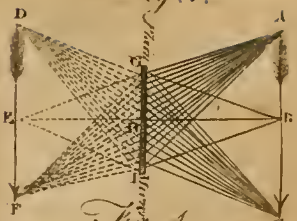


Fig. 2.

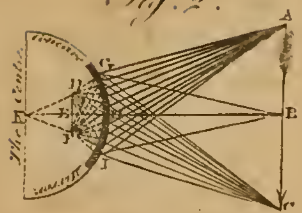


Fig. 3.

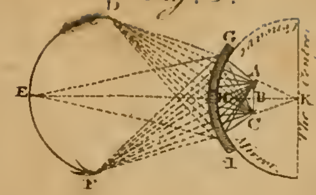


Fig. 8.

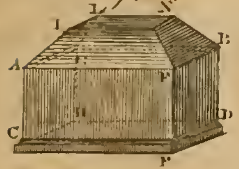


Fig. 4.

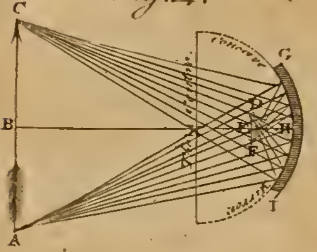


Fig. 7.

Fig. 6.

Fig. 9.

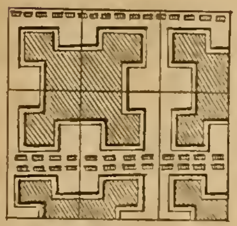


Fig. 10.

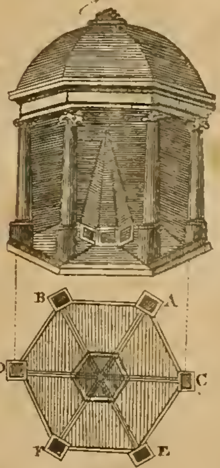


Fig. 5.

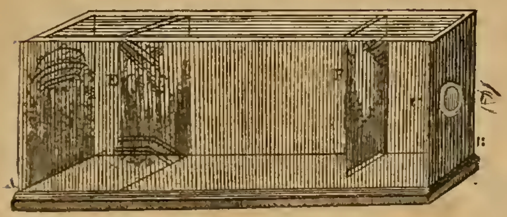


Fig. 11.

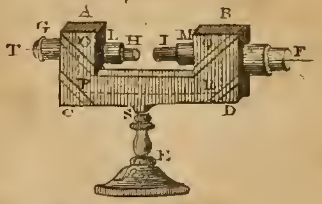


Fig. 12.

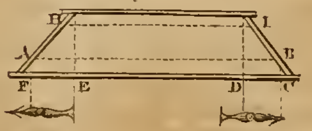


Fig. 13.

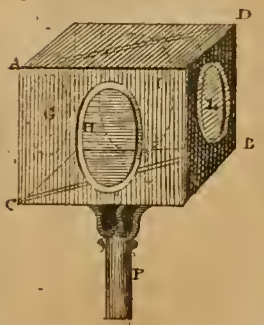


Fig. 14.

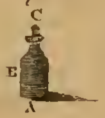


Fig. 15.

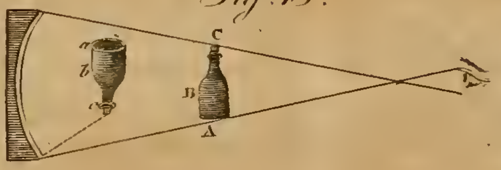


Fig. 17.

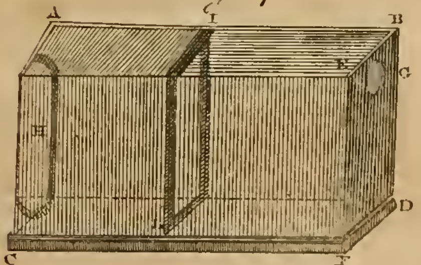
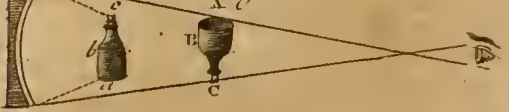


Fig. 16.



Cat head.

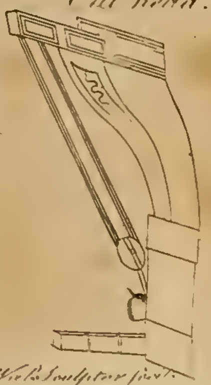


Fig. 18.

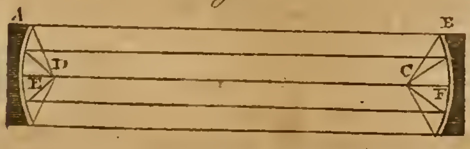
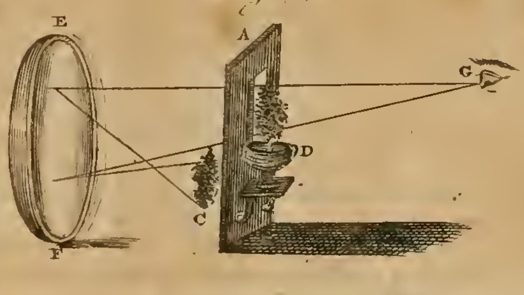


Fig. 19.



A. Bell Prin. Wal. Sculptor fecit.

round, the reflected image will go out perpendicular to the direction of the ſword preſented, and apparently come to another perſon placed in the direction of the motion of the image. If that perſon is unacquainted with the experiment, and does not ſee the original ſword, he will be much ſurpriſed and alarmed. This experiment may be another way diverſified, by telling any perſon, that at ſuch an hour, and in ſuch a place, he ſhould ſee the apparition of an abſent or deceaſed friend (of whoſe portrait you are in poſſeſſion). In order to produce this phantom, inſtead of the hole in the partition AB in the laſt figure, there muſt be a door which opens into an apartment to which there is a conſiderable deſcent. Under that door you are to place the portrait, which muſt be inverted and ſtrongly illuminated, that it may be lively reflected by the mirror, which muſt be large and well poliſhed. Then having introduced the incredulous ſpectator at another door, and placed him in the proper point of view, you ſuddenly throw open the door at AB, when, to his great aſtoniſhment, he will immediately ſee the apparition of his friend.

It will be objected, perhaps, that this is not a perfect apparition, becauſe it is only viſible at one point of view, and by one perſon. But it ſhould be remembered, that it was an eſtabliſhed maxim in the laſt centuries, that a ſpectre might be viſible to one perſon and not to others. So Shakeſpeare makes both Hamlet and Macbeth ſee apparitions that were not viſible to others preſent at the ſame time. It is not unlikely, moreover, that this maxim took its riſe from certain apparitions of this kind that were raiſed by the monks, to ſerve ſome purpoſes they called religious; as they alone were in poſſeſſion of what little learning there then was in the world.

Opticians ſometimes grind a glaſs mirror concave in one direction only, as it is ſaid longitudinally; it is in fact a concave portion of a cylinder, the breadth of which may be conſidered that of the mirror. A perſon looking at his face in this mirror, in the direction of its concavity, will ſee it curiouſly diſtorted in a very lengthened appearance; and by turning the cylindrical mirror a quarter round, his viſage will appear diſtorted another way, by an aparent increaſe in width only. Another curious and ſingular property attends this ſort of mirror: If in a very near ſituation before it, you put your finger on the right hand ſide of your noſe, it will appear the ſame in the mirror; but if in a diſtant ſituation, ſomewhat beyond the centre of concavity, you again look at your face in the mirror, your finger will appear to be removed to the other or left hand ſide of your noſe. This, though ſomething extraordinary, will in its cauſe appear very evident from a ſmall conſideration of the properties of ſpherical concave mirrors.

CATOPTROMANCY, Κατοπτρομαντεια, a kind of divination among the ancients; ſo called, becauſe conſiſting in the application of a mirror. The word is formed from κατοπτρον, *ſpeculum*, "mirror," and μαντεια, *divinatio*, "divination." Pauſanias ſays, it was in uſe among the Achaians; where thoſe who were ſick, and in danger of death, let down a mirror, or looking glaſs faſtened by a thread, into a fountain before the temple of Ceres; then looking in the glaſs, if they ſaw a ghaſtly disfigured face, they took it as a ſure ſign of death: on the contrary, if the fleſh appeared freſh and healthy, it was a token of recovery. Sometimes glaſſes were uſed without water, and the images of things future repreſented in them. See Gastromancy.

CATROU, Francis, a famous Jeſuit, born at Paris in 1659. He was engaged for 12 years in the *Journal de Trevoux*, and applied himſelf at the ſame time to other works, which diſtinguiſhed him among the learned. He wrote a general Hiſtory of the Mogul empire, and a Roman Hiſtory, in which he was aſſiſted by Father Rouille, a brother Jeſuit. Catrou died in 1737; and this laſt hiſtory was continued by Rouille, who died in 1740.

CATTERTHUN, a remarkable Caledonian poſt a few miles north of the town of Brechin in the county of Angus in Scotland. Mr Pennant deſcribes it as of uncommon ſtrength. "It is, (ſays he) of an oval form, made of a ſtupendous dike of looſe white ſtones, whoſe convexity, from the baſe within to that without, is 122 feet. On the outſide a hollow, made by the diſpoſition of the ſtones, ſurrounds the whole. Round the baſe is a deep ditch, and below that about 100 yards, are veſtiges of another, that went round the hill. The area within the ſtony mound is flat; the axis, or length of the oval, is 436 feet, the tranſverſe diameter 200. Near the eaſt ſide is the foundation of a rectangular building; and on moſt parts are the foundations of others ſmall and circular: all which had once their ſuperſtructures, the ſhelter of the poſſeſſors of the poſt: there is alſo a hollow, now almoſt filled with ſtones, the well of the place." There is another fortification, but of inferior ſtrength, in the neighbourhood. It is called the *Brown Catterthun*, from the colour of the ramparts, which are compoſed only of earth. It is of a circular form, and conſiſts of various concentric dikes. On one ſide of this riſes a ſmall rill, which, running down the hill, has formed a deep gully. From the ſide of the fortreſs is another rampart, which extends parallel to the rill, and then reverts, forming an additional poſt or retreat. The meaning of the word *Catter-thun* is *Camp-town*; and Mr Pennant thinks theſe might probably be the poſts occupied by the Caledonians before their engagement at the foot of the Grampian mountains with the celebrated Agricola. See (*Hiſtory of*) Scotland.

CATTI, a people of Germany, very widely ſpread, on the eaſt reaching to the river Sala, on the north to Weſtphalia; occupying, beſides Heſſe, the Wetterau, and part of the tract on the Rhine, and on the banks of the river Lohne. The Hercynian foreſt began and ended in their country.

CATTIVELLAUNI, anciently a people of Britain, ſeated in the country which is now divided into the counties of Hertford, Bedford, and Bucks. The name of this ancient Britiſh people is written in ſeveral different ways by Greek and Roman authors, being ſometimes called Catti, Caſſii, Catticulcani, Cattidudani, Catticludani, &c. That they were of Belgic origin cannot be doubted; and it is not improbable that they derived their name of Catti from the Belgic word Katten, which ſignifies illuſtrious or noble, and that the addition of Vellauni, which means on the banks of rivers, might be given them after their arrival in Britain, as deſcriptive of the ſituation of their country. However this may be, the Cattivellauni formed one of the moſt brave and warlike of the ancient Britiſh nations when Cæſar invaded Britain, and long after. Caſſibelanus, their prince, was made commander in chief of the confederated Britons, not only on account of his own perſonal qualities, but alſo becauſe he was at the head of one of their braveſt and moſt powerful tribes. In the interval between the departure of Cæſar and the next invaſion under Claudius, the Cattivellauni had reduced ſeveral of the neighbouring ſtates under their obedience; and they again took the lead in oppoſition to the Romans at their ſecond invaſion, under their brave but unfortunate Prince Caractacus. The country of the Cattivellauni was much frequented and improved by the Romans, after it came under their obedience. Verulamium, their capital, which ſtood near where St Alban's now ſtands, became a place of great conſideration, was honoured with the name and privileges of a municipium or free city, and had magiſtrates after the model of the city of Rome. This place was taken and almoſt deſtroyed by the inſurgents under Boadicea; but it was afterwards rebuilt, reſtored to its former ſplendour, and ſurrounded with a ſtrong wall, ſome veſtiges of which are ſtill remaining. Durocobrivæ and Magiavintum, in the ſecond iter of Antoninus, were probably Dunſtable and Fenny Stratford, at which places there appear to have been Roman ſtations. The Salenæ of Ptolemy, a town in the country of the Cattivellauni, was perhaps ſituated at Salndy in Bedfordſhire, where ſeveral Roman antiquities have been found. There were, beſides theſe, ſeveral other Roman forts, ſtations, and towns in this country, which it would be tedious to enumerate. The territories of the Cattivellauni made a part of the Roman province called Britannia Prima.

CATTLE, a collective word, which ſignifies the fourfooted animals, which ſerve either for tilling the ground, or for food to man. They are diſtinguiſhed into large or black cattle; and into ſmall cattle: of the former are horſes, bulls, oxen, cows, and even calves, and heifers; amongſt the latter are rams, ewes, ſheep, lambs, goats, kids, &c. Cattle are the chief ſtock of a farm: they who deal in cattle are ſtyled graziers.

CATULLUS, Caius Valerius, a Latin poet, born at Verona, in the year of Rome 666. The harmony of his numbers acquired him the eſteem and friendſhip of Cicero, and other great men of his time. Many of his poems, however, abound with groſs obſcenities. He wrote ſatirical verſes againſt Cæſar, under the name of Marmoro. He ſpent his whole life in a ſtate of poverty; and died in the flower of his age and the height of his reputation. Joſeph Scaliger, Paſſerat, Muret, and Iſaac Voſſius, have written learned notes on this poet.

CATZ, James, a great civilian, politician, and Dutch poet, was born at Browerſhaven, in Zealand, in the year 1577. After having made ſeveral voyages, he fixed at Middleburg; and acquired by his pleadings ſuch reputation, that the city of Dort choſe him for its penſionary; as did alſo, ſome time after, that of Middleburg. In 1634, he was nominated penſionary of Holland and Weſt Frieſland; and in 1648, he was elected keeper of the ſeal of the ſame ſtate, and ſtadtholder of the fiefs: but ſome time after, he reſigned theſe employments, to enjoy the repoſe which his advanced age demanded. As the poſt of grand penſionary had been fatal to almoſt all thoſe who had enjoyed it, from the beginning of the republic 'till that time, Catz delivered up his charge on his knees, before the whole aſſembly of the ſtates, weeping for joy, and thanking God for having preſerved him from the inconveniences that ſeemed attached to the duties of that office. But though he was reſolved to ſpend the reſt of his days in repoſe, the love of his country engaged him to comply with the deſires of the ſtate, who importuned him to go on an embaſſy to England, in the delicate conjuncture in which the republic found itſelf during the protectorate of Cromwell. At his return, he retired to his fine country ſeat at Sorgvliet, where he lived in tranquillity till the year 1660, in which he died. He wrote a great number of poems in Dutch; moſt of which are on moral ſubjects, and ſo eſteemed, that they have been often printed in all the different ſizes; and, next to the Bible, there is no work ſo highly valued by the Dutch.

CATZENELLIBOGEN, a town of Germany, in the lower part of the upper circle of the Rhine, with a ſtrong caſtle. It is capital of a county of the ſame name. E. Long. 7. 38. N. Lat. 50. 20.

CAVA, in *Anatomy*, the name of a vein, the largeſt in the body, terminating in the right ventricle of the heart. See Anatomy *Index*.

Cava, a conſiderable and populous town of Italy, in the kingdom of Naples, and in the Hither Principato, with a biſhop's ſee. It is ſituated at the foot of Mount Metelian, in E. Long. 15. 5. N. Lat. 40. 40.

CAVAILLAN, a town of France, in the department of Vaucluſe, and formerly a biſhop's ſee. It is ſituated on the river Durance, in a fertile and pleaſant country, and 20 miles ſouth-eaſt of Avignon. E. Long. 4. 17. N. Lat. 43. 52.

CAVALCADE, a formal pompous march or proceſſion of horſemen, equipages, &c. by way of parade or ceremony, to grace a triumph, public entry, or the like.

CAVALCADOUR, or Cavalcadeur, anciently denoted a riding maſter; but at preſent is diſuſed in that ſenſe, and only employed to denote a ſort of equerries or officers who have the direction of princes ſtables. The French ſay, *ecuyer cavalcadeur* of the king, the duke of Orleans, &c. Menage writes it *cavalcadour*, and derives it from the Spaniſh *cavalgador*, a horſeman.

CAVALCANTE, Guido, a nobleman of Florence in the 13th century, who having followed the party of the Guelphs, experienced the changeableneſs of fortune. He ſhowed great ſtrength of mind in his miſfortunes, and never neglected to improve his talents. He wrote a treatiſe in Italian concerning ſtyle, and ſome verſes which are eſteemed. His poem on the love of this world has been commented on by ſeveral learned men.

CAVALIER, a horſeman, or perſon mounted on horſeback: eſpecially if he be armed withal, and have a military appearance.

Anciently the word was reſtrained to a knight, or *miles*. The French ſtill uſe *Chevalier* in the ſame ſenſe.

CAVALIER, conſidered as a faction. See BRITAIN, N° 109.

CAVALIER, in fortification, an elevation of earth of different ſhapes, ſituated ordinarily in the gorge of a baſtion, bordered with a parapet, and cut into more or leſs embraſures, according to the capacity of the cavalier. Cavaliers are a double defence for the faces of the oppoſite baſtion: they defend the ditch, break the beſiegers galleries, command the traverſes in dry moats, ſcour the ſalient angle of the counterſcarp, where the beſiegers have their counter batteries, and enfilade the enemy's trenches, or oblige them to multiply their parallels: they are likewiſe very ſerviceable in defending the breach and the retrenchments of the beſieged, and can very much incommode the intrenchments which the enemy make, being lodged in the baſtion.

CAVALIER, in the manege, one that underſtands horſes, and is practiſed in the art of riding them.

CAVALIERI, BONAVENTURE, an eminent mathematician in the 17th century, a native of Milan, and a friar of the order of the Jeſuati of St Jerome, was profeſſor of the mathematics at Bologna, where he publiſhed ſeveral mathematical books, particularly the "Method of Indiviſibles." He was a ſcholar of Galileo. His *Directorium generale Uranometricum* contains great variety of moſt uſeful practices in trigonometry and aſtronomy. His trigonometrical tables in that work are excellent.

CAVALRY, a body of ſoldiers that charge on horſeback. The word comes from the French, *cavalerie*, and that from the corrupt Latin, *caballus*, a horſe.

The Roman cavalry conſiſted wholly of thoſe called *equites*, or knights, who were a diſtinct order in the diſtribution of citizens.—The Grecian cavalry were divided into *cataphractæ* and *non cataphractæ*, i. e. into heavy and light armed.— Of all the Greeks, the Theſſalians excelled moſt in cavalry. The Lacedæmonians, inhabiting a mountainous country, were but meanly furniſhed with cavalry, till, carrying their arms into other countries, they found great occaſion for horſes to ſupport and cover their foot. The Athenian cavalry, for a conſiderable time, conſiſted only of 96 horſemen: after expelling the Perſians out of Greece, they increaſed the number to 300; and afterwards to 1200, which was the higheſt pitch of the Athenian cavalry. The Turkiſh cavalry conſiſts partly of Saphis, and partly of horſemen raiſed and maintained by the Zaims and Timariots.

The chief uſe of the cavalry is to make frequent excurſions to diſturb the enemy, intercept his convoys, and deſtroy the country; in battle to ſupport and cover the foot, and to break through and diſorder the enemy; alſo to ſecure the retreat of the foot. Formerly, the manner of fighting of the cavalry was, after firing their piſtols or carabines, to wheel off, to give opportunity for loading again. Guſtavus Adolphus is ſaid to have firſt taught the cavalry to charge through, to march ſtraight up to the enemy, with the ſword drawn in the bridle hand, and each man having fired his piece, at the proper diſtance, to betake himſelf to his ſword, and charge the enemy as was found moſt advantageous.

CAVAN, a town of Ireland, and capital of a county of the ſame name, in the province of Ulſter, ſituated in W. Long. 6. 32. N. Lat. 54. 0.

CAVAN, a county of Ireland, 47 miles in length and 23 in breadth; is bounded on the eaſt by Monaghan, and on the ſouth by Longford, Weſt-Meath, and Eaſt-Meath. It has but two towns of any note, viz. Cavan and Kilmore. It ſends five members to parliament; two for the county, two for Cavan, and one for Kilmore. It contains upwards of 8000 houſes, 37 pariſhes, ſeven baronies, and two boroughs.

CAUCASUS, the name of a very high mountain of Aſia, being one of that great ridge which runs between the Black and Caſpian ſeas. Sir John Chardin deſcribes this as the higheſt mountain, and the moſt difficult to paſs, of any he had ſeen. It has frightful precipices, and in many places the roads are cut out of the ſolid rock. At the time he paſſed it, the mountain was entirely covered with ſnow; ſo that, in many places, his guides behoved to clear the way with ſhovels. The mountain is 36 leagues over, and the ſummit of it eight leagues in breadth. The top is perpetually covered with ſnow; and our traveller relates, that the two laſt days he ſeemed to be in the clouds, and was not able to ſee 20 paces before him. Excepting the very top, however, all the parts of Mount Caucaſus are extremely fruitful; abounding in honey, corn, fruits, hogs, and large cattle. The vines twine about the trees, and riſe ſo high, that the inhabitants cannot gather the fruit from the uppermoſt branches. There are many ſtreams of excellent water, and a vaſt number of villages. The inhabitants are for the moſt part Chriſtians of the Georgian church. They have fine complexions, and the women are very beautiful.—In the winter they wear ſnow ſhoes in the form of rackets, which prevent their ſinking in the ſnow, and enable them to run upon it with great ſwiftneſs.

CAUDEBEC, a rich, populous, and trading town, in Normandy, and capital of the territory of Caux. It is ſeated at the foot of a mountain near the river Seine, in E. Long. 0. 46. N. Lat. 40. 30.

CAUDEX, by Malpighi and other botaniſts, is uſed to ſignify the ſtem or trunk of a tree; by Linnæus, the ſtock or body of the root, part of which aſcends, part deſcends. The aſcending part raiſes itſelf gradually above ground, ſerving frequently for a trunk, and correſponds in ſome meaſure to the *caudex* of former writers: the deſcending part ſtrikes gradually downward into the ground, and puts forth radicles or ſmall fibres, which are the principal and eſſential part of every root. The deſcending caudex therefore correſponds to the radix of other botaniſts. Agreeably to this idea, Linnæus conſiders trees and ſhrubs as roots above ground; an opinion which is confirmed by a well known fact, that trees, when inverted, put forth leaves from the deſcending caudex, and radicles or roots from the aſcending. For the varieties in the deſcending caudex, ſee the article Radix.

CAUDIUM, in *Ancient Geography*, a town of Samnium, on the Via Appia, between Calatia and Beneventum: *Caudinus*, the epithet. The *Caudinæ Furcæ, Furcatæ*, were memorable by the diſgrace of the Romans; being ſpears diſpoſed in the form of a gallows under which priſoners of war were made to paſs, and gave name to a defile or narrow paſs near *Caudium* (Livy); where the Samnites obliged the Roman army and the two conſuls to lay down their arms and paſs under the gallows, or yoke, as a token of ſubjection.

CAVE, any large ſubterraneous hollow. Theſe were undoubtedly the primitive habitations, before men began to build edifices above ground. The primitive method of burial was alſo to repoſite the bodies in caves, which ſeems to have been the origin of catacombs. They long continued the proper habitations of ſhepherds. Among the Romans, *caves (antra)* uſed to be conſecrated to nymphs, who were worſhipped in caves, as other gods were in temples. The Perſians alſo worſhipped their god Mithras in a natural cave conſecrated for the purpoſe by Zoroaſter. The cave of the nymph Egeria is ſtill ſhown at Rome. Kircher, after Gaſſarellus, enumerates divers ſpecies of caves; as divine, natural, &c.—Of natural caves ſome are poſſeſſed of a medicinal virtue, as the Grotto de Serpente; others are poiſonous or mephitical; ſome are replete with metalline exhalations, and others with waters. Divine caves were thoſe ſaid to affect the human mind and paſſions in various ways, and even to inſpire with a knowledge of future events. Such were the ſacred caverns at Delphi which inſpired the Pythia; the Sibyl's cave at Cumæ, ſtill ſhown near the lake Avernus; the cave of Trophonius, &c.

Cave, *Dr William*, a learned Engliſh divine, born in 1637, educated in St John's College, Cambridge; and ſucceſſively miniſter of Haſely in Oxfordſhire, Allhallows the Great in London, and of Iſlington. He became chaplain to Charles II. and in 1684 was inſtalled a canon of Windſor. He compiled *the Lives of the Primitive Fathers in the three firſt Centuries of the Church*, which is eſteemed a very uſeful work; and *Hiſtoria Literaria*, &c. in which he gives an exact account of all who had written for or againſt Chriſtianity from the time of Chriſt to the 14th century: which works produced a very warm diſpute between Dr Cave and M. Le Clerc, who was then writing his *Bibliotheque Univerſelle* in Holland, and who charged the doctor with partiality. Dr Cave died in 1713.

Cave, *Edward*, printer, celebrated as the projector of the *Gentleman's Magazine*,—the firſt publication of the ſpecies, and ſince

> The fruitful mother of a thouſand more,

was born in 1691. His father being diſappointed of ſome ſmall family expectations, was reduced to follow the trade of ſhoemaker at Rugby in Warwickſhire. The free ſchool of this place, in which his ſon had, by the rules of its foundation, a right to be inſtructed, was then in high reputation, under the Rev. Mr Holyock, to whoſe care moſt of the neighbouring families, even of the higheſt rank, intruſted their ſons. He had judgment to diſcover, and for ſome time generoſity to encourage, the genius of young Cave; and was ſo well pleaſed with his quick progreſs in the ſchool, that he declared his reſolution to breed him for the univerſity, and recommend him as a ſervitor to ſome of his ſcholars of high rank. But proſperity which depends upon the caprice of others, is of ſhort duration. Cave's ſuperiority in literature exalted him to an invidious familiarity with boys who were far above him in rank and expectations; and, as in unequal aſſociations it always happens, whatever unlucky prank was played was imputed to Cave. When any miſchief, great or ſmall, was done, though perhaps others boaſted of the ſtratagem when it was ſucceſsful, yet upon detection or miſcarriage, the fault was ſure to fall to poor Cave. The harſh treatment he experienced from this ſource, and which he bore for a while, made him at laſt leave the ſchool, and the hope of a literary education, to ſeek ſome other means of gaining a livelihood.

He was firſt placed with a collector of the exciſe; but the inſolence of his miſtreſs, who employed him in ſervile drudgery, quickly diſguſted him, and he went up to London in queſt of more ſuitable employment. He was recommended to a timber merchant at the Bankſide: and while he was there on liking, is ſaid to have given hopes of great mercantile abilities: but this place he ſoon left; and was bound apprentice to Mr Collins, a printer of ſome reputation, and deputy alderman. This was a trade for which men were formerly qualified by a literary education, and which was pleaſing to Cave, becauſe it furniſhed ſome employment for his ſcholaſtic attainments. Here, therefore, he reſolved to ſettle, though his maſter and miſtreſs lived in perpetual diſcord, and their houſe was therefore no comfortable habitation. From the inconveniences of theſe domeſtic tumults he was ſoon releaſed, having in only two years attained ſo much ſkill in his art, and gained ſo much the confidence of his maſter, that he was ſent without any ſuperintendant to conduct a printing houſe at Norwich, and publiſh a weekly paper. In this undertaking he met with ſome oppoſition, which produced a public controverſy, and procured young Cave the reputation of a writer.

His maſter died before his apprenticeſhip was expired, and he was not able to bear the perverſeneſs of his miſtreſs. He therefore quitted her houſe upon a ſtipulated allowance, and married a young widow, with whom he lived at Bow. When his apprenticeſhip was over, he worked as a journeyman at the printing-houſe of Mr Barbar, a man much diſtinguiſhed and employed by the Tories, whoſe principles had at that time ſo much prevalence with Cave, that he was for ſome years a writer in Miſt's Journal. He afterwards obtained by his wife's intereſt a ſmall place in the poſt-office; but ſtill continued, at his intervals of attendance, to exerciſe his trade, or to employ himſelf with ſome typographical buſineſs. He corrected the *Gradus ad Parnaſſum*; and was liberally rewarded by the

Company of Stationers. He wrote an Account of the Criminals, which had for ſome time a conſiderable ſale; and publiſhed many little pamphlets that accident brought into his hands, of which it would be very difficult to recover the memory. By the correſpondence which his place in the poſt-office facilitated, he procured a country newſpaper, and ſold their intelligence to a journaliſt in London for a guinea a-week. He was afterwards raiſed to the office of clerk of the franks, in which he acted with great ſpirit and firmneſs; and often ſtopped franks which were given by members of parliament to their friends, becauſe he thought ſuch extenſion of a peculiar right illegal. This raiſed many complaints: and the influence that was exerted againſt him procured his ejectment from office. He had now, however, collected a ſum ſufficient for the purchaſe of a ſmall printing office, and began the Gentleman's Magazine; an undertaking to which he owed the affluence in which he paſſed the laſt 20 years of his life, and the large fortune which he left behind him. When he formed the project, he was far from expecting the ſucceſs which he found; and others had ſo little proſpect of its conſequence, that though he had for ſeveral years talked of his plan among printers and bookſellers, none of them thought it worth the trial. That they were not (ſays Dr Johnſon) reſtrained by their virtue from the execution of another man's deſign, was ſufficiently apparent as ſoon as that deſign began to be gainful; for, in a few years, a multitude of magazines aroſe, and periſhed; only the London Magazine, ſupported by a powerful aſſociation of bookſellers, and circulated with all the art and all the cunning of trade, exempted itſelf from the general fate of Cave's invaders, and obtained though not an equal, yet a conſiderable ſale.

Cave now began to aſpire to popularity; and being a greater lover of poetry than any other art, he ſometimes offered ſubjects for poems, and propoſed prizes for the beſt performers. The firſt prize was 50l. for which, being but newly acquainted with wealth, and thinking the influence of 50l. extremely great, he expected the firſt authors of the kingdom to appear as competitors, and offered the allotment of the prize to the univerſities. But, when the time came, no name was ſeen among the writers that had been ever ſeen before; and the univerſities and ſeveral private men rejected the province of aſſigning the prize. The determination was then left to Dr Cromwell Mortimer and Dr Birch; and by the latter the award was made, which may be ſeen in Gent. Mag. vol. vi. p. 59.

Mr Cave continued to improve his Magazine, and had the ſatisfaction of ſeeing its ſucceſs proportionate to his diligence, till in 1751, his wife died of an aſthma. He ſeemed not at firſt much affected by her death, but in a few days loſt his ſleep and his appetite, which he never recovered. After having lingered about two years, with many viciſſitudes of amendment and relapſe, he fell by drinking acid liquors into a diarrhœa, and afterwards into a kind of lethargic inſenſibility; and died Jan. 10. 1754, having juſt concluded the 23d annual collection.

CAVEARE. See Caviare.

CAVEAT, in *Law*, a kind of proceſs in the ſpiritual courts, to ſtop the proving of a will, the granting tithes of adminiſtration, &c. to the prejudice of another. It is alſo uſed to ſtop the inſtitution of a clerk to a benefice.

CAVEATING, in *Fencing*, is the ſhifting the ſword from one ſide of that of your adverſary to the other.

CAVEDO, in *Commerce*, a Portugueſe long meaſure, equal to $27\frac{154}{1000}$ Engliſh inches.

CAVENDISH, Thomas, of Suffolk, the ſecond Engliſhman that ſailed round the globe, was deſcended from a noble family in Devonſhire. Having diſſipated his fortune, he reſolved to repair it at the expence of the Spaniards. He ſailed from Plymouth with two ſmall ſhips in July 1586; paſſed through the ſtraits of Magellan; took many rich prizes along the coaſts of Chili and Peru; and near California, poſſeſſed himſelf of the St Ann, an Acapulco ſhip, with a cargo of immenſe value. He completed the circumnavigation of the globe, returning home round the Cape of Good Hope, and reached Plymouth again in September 1588. On his arrival, it is ſaid that his ſoldiers and ſailors were clothed in ſilk, his ſails were damaſk, and his top-maſt was covered with cloth of gold. His acquired riches did not laſt long: he reduced himſelf, in 1591, to the expedient of another voyage; which was far from being ſo ſucceſsful as the former; he went no farther than the ſtraits of Magellan, where the weather obliging him to return, he died of grief on the coaſt of Braſil.

Cavendish, *Sir William*, deſcended of an ancient and honourable family, was born about the year 1505, the ſecond ſon of Thomas Cavendiſh of Cavendiſh in Suffolk, clerk of the pipe in the reign of Henry VIII. Having had a liberal education, he was taken into the family of the great Cardinal Wolſey, whom he ſerved in the capacity of gentleman-uſher of the chamber, when that ſuperb prelate maintained the dignity of a prince. In 1527, he attended his maſter on his ſplendid embaſſy to France, returned with him to England, and was one of the few who continued faithful to him in his diſgrace. Mr Cavendiſh was with him when he died, and delayed going to court till he had performed the laſt duty of a faithful ſervant by ſeeing his body decently interred. The king was ſo far from diſapproving of his conduct, that he immediately took him into his houſehold, made him treaſurer of his chamber, a privy counſellor, and afterwards conferred on him the order of knighthood. He was alſo appointed one of the commiſſioners for taking the ſurrender of religious houſes. In 1540, he was nominated one of the auditors of the court of augmentations, and ſoon after obtained a grant of ſeveral conſiderable lordſhips in Hertfordſhire. In the reign of Edward VI. his eſtates were much increaſed by royal grants in ſeven different counties; and he appears to have continued in high favour at court during the reign of Queen Mary. He died in the year 1557. He was the founder of Chatſworth, and anceſtor of the dukes of Devonſhire. He wrote "The life and death of Cardinal Wolſey;" printed at London in 1667; reprinted in 1706, under the title of "Memoirs of the great favourite Cardinal Wolſey."

Cavendish, *William*, duke of Newcaſtle, grandſon of Sir William Cavendiſh, was born in 1592. In 1610, he was made knight of the Bath; in 1620, raiſed to the dignity of a peer, by the title of Baron

Ogle, and Viſcount Mansfield ; and in the third year of King Charles I. created earl of Newcaſtle upon Tyne, and Baron Cavendiſh of Boleſover. He was after this made governor to the prince of Wales, afterwards Charles II. When the firſt troubles broke out in Scotland, and the king's treaſury was but indifferently provided, he contributed ten thouſand pounds, and alſo raiſed a troop of horſe, conſiſting of about two hundred knights and gentlemen, who ſerved at their own charge, were commanded by the earl, and honoured with the title of *the prince's troop*. He had after this the command of the northern counties ; and was conſtituted general and commander in chief of all the forces that might be raiſed north of Trent, and of ſeveral counties ſouth of that river. He afterwards raiſed an army of eight thouſand horſe, foot, and dragoons ; with which he took ſome towns, and gained ſeveral important victories. On this he was advanced to the dignity of marquis of Newcaſtle ; but his majeſty's affairs being totally ruined by the raſhneſs of Prince Rupert, he, with a few of the principal officers of the army, went abroad, and ſtaid for ſome time at Paris ; where, notwithſtanding the vaſt eſtate he had when the civil war broke out, his circumſtances were now ſo bad, that himſelf and wife were reduced to the neceſſity of pawning their clothes for a dinner. He afterwards removed to Antwerp, that he might be nearer his own country ; and there, though under great difficulties, reſided for ſeveral years ; but, notwithſtanding his diſtreſſes, he was treated, during an exile of eighteen years, with extraordinary marks of diſtinction. On his return to England at the Reſtoration, he was advanced to the dignity of earl of Ogle, and duke of Newcaſtle. He ſpent his time in a country retirement, and was the patron of men of merit. His grace died in 1670, aged 84. He wrote a treatiſe on horſemanſhip, which is eſteemed : and ſome comedies, which are not.

Mr Granger obſerves, that he was maſter of many accompliſhments, and was much better qualified for a court than a camp ; that he underſtood horſemanſhip, muſic, and poetry ; but was a better horſeman than muſician, and a better muſician than poet.

CAVENDISH, *Margaret*, ducheſs of Newcaſtle, famous for her voluminous productions, was born about the latter end of the reign of James I. and was the youngeſt ſiſter of Lord Lucas of Colcheſter. She married the duke of Newcaſtle abroad in 1645 ; and on their return after the Reſtoration, ſpent the remainder of her life in writing plays, poems, with the life of her huſband, to the amount of about a dozen of folios. "What gives the beſt idea of her unbounded paſſion for ſcribbling (ſays Mr Walpole), was her ſeldom reviſing the copies of her works, leſt, as ſhe ſaid, it ſhould diſturb her following conceptions. She died in 1673.

CAVENDISH, *William*, the firſt duke of Devonſhire, and one of the moſt diſtinguiſhed patriots in the Britiſh annals, was born in 1640. In 1677, being then member for Derby, he vigorouſly oppoſed the venal meaſures of the court ; and, the following year, was one of the committee appointed to draw up articles of impeachment againſt the Lord treaſurer Danby. In 1679, being re-elected to ſerve for Derby in a new parliament, Charles II. thought fit to make him a privy counſellor; but he ſoon withdrew from the board, with his friend Lord Ruſſel, when he found that Popiſh intereſt prevailed. He carried up the articles of impeachment to the houſe of lords, againſt Lord-chief-juſtice Scroggs, for his arbitrary and illegal proceedings in the court of king's bench ; and when the king declared his reſolution not to ſign the bill for excluding the duke of York (afterwards James II.), he moved the houſe of commons, that a bill might be brought in for the aſſociation of all his majeſty's Proteſtant ſubjects. He alſo openly named the king's evil counſellors, and voted for an addreſs to remove them from his preſence and councils for ever. He nobly appeared at Lord Ruſſel's trial, in defence of that great man, at a time when it was ſcarce more criminal to be an accomplice than a witneſs for him. The ſame fortitude, activity, and love of his country, animated this illuſtrious patriot to oppoſe the arbitrary proceedings of James II. ; and when he ſaw there was no other method of ſaving the nation from impending ſlavery, he was the foremoſt in the aſſociation for inviting over the prince of Orange, and the firſt nobleman who appeared in arms to receive him at his landing. He was created duke of Devonſhire in 1694, by William and Mary. His laſt public ſervice was in the union with Scotland, for concluding of which he was appointed a commiſſioner by Queen Anne. He died in 1707, and ordered the following inſcription to be put on his monument.

Willielmus dux Devon,
Bonorum Principum Fidelis Subditus,
Inimicus et Inviſus Tyrannis.
William Duke of Devonſhire,
Of good Princes the faithful Subject,
The Enemy and Averſion of Tyrants.

Beſides being thus eſtimable for public virtues, his grace was diſtinguiſhed by his literary accompliſhments. He had a poetical genius, which ſhowed itſelf particularly in two pieces written with equal ſpirit, dignity, and delicacy : theſe are, an Ode on the Death of Queen Mary; and an Alluſion to the Archbiſhop of Cambray's Supplement to Homer. He had great knowledge in the languages, was a true judge in hiſtory, and a critic in poetry ; he had a fine hand in muſic, an elegant taſte in painting, and in architecture had a ſkill equal to any perſon of the age in which he lived. His predeceſſor, Sir John Cavendiſh, was the perſon who killed the famous Watt Tyler in 1381.

CAVETTO, in *Architecture*, a hollow member, or round concave moulding, containing a quadrant of a circle, and having a quite contrary effect to that of a quarter round ; it is uſed as an ornament in cornices.

CAVEZON, in the manege, a ſort of noſe band, either of iron, leather, or wood, ſometimes flat, and at other times hollow or twiſted, clapt upon the noſe of a horſe to wring it, and ſo forward the ſuppling and breaking of the horſe.

CAVIARE, a kind of food lately introduced into Britain. It is made of the hard roes of ſturgeon *, formed into ſmall cakes, about an inch thick and three or four inches broad. The method of making it is, by taking out of the ſpawn all the nerves or ſtrings, then waſhing it in white wine or vinegar, and ſpread-

* See *Accipenſer.*

ing it on a table. It is then ſalted and preſſed in a fine bag; after which it is caſed up in a veſſel with a hole at the bottom, that if any moiſture is left it may run out. This kind of food is in great requeſt among the Muſcovites, on account of their three lents, which they keep with a ſuperſtitious exactneſs; wherefore the Italians ſettled at Moſcow drive a very great trade in this commodity throughout that empire, there being a prodigious quantity of ſturgeon taken at the mouth of the Wolga and other rivers which fall into the Caſpian ſea. A pretty large quantity of the commodity is alſo conſumed in Italy and France. They get the caviare from Archangel, but commonly buy it at ſecond hand of the Engliſh and Dutch.—According to Savary, the beſt caviare brought from Muſcovy is prepared from the belluga, a fiſh eight or ten feet long, caught in the Caſpian ſea, which is much preferable to that made of the ſpawn of a ſturgeon. A kind of caviare, or rather ſauſage, is alſo made from the ſpawn of ſome other fiſhes; particularly a ſort of mullet caught in the Mediterranean. See Mugil and Botargo.

CAVIDOS. See Cabidos.

CAVIL *(cavillatio)*, is defined by ſome a fallacious kind of reaſon, carrying ſome reſemblance of truth, which a perſon, knowing its falſehood, advances in diſpute for the ſake of victory. The art of framing ſophiſms or fallacies is called by Boethius *cavillatoria.*

CAUK, or Cawk. See Barytes, Chemistry and Mineralogy *Index.*

CAUKING, or *Caulking of a Ship*, is driving a quantity of oakum, or old ropes untwiſted and drawn aſunder, into the ſeams of the planks, or into the intervals where the planks are joined together in the ſhip's decks or ſides, in order to prevent the entrance of water. After the oakum is driven very hard into theſe ſeams, it is covered with hot melted pitch or roſin, to keep the water from rotting it.

Among the ancients, the firſt who made uſe of pitch in caulking, were the inhabitants of Phæacia, afterwards called Corſica. Wax and roſin appear to have been commonly uſed previous to that period; and the Poles at this time uſe a ſort of unctuous clay for the ſame purpoſe on their navigable rivers.

Caulking Irons, are iron chiſſels for that purpoſe. Some of theſe irons are broad, ſome round, and others grooved. After the ſeams are ſtopped with oakum, it is done over with a mixture of tallow, pitch, and tar, as low as the ſhip draws water.

CAUL, in *Anatomy*, a membrane in the abdomen, covering the greateſt part of the guts; called, from its ſtructure, *Reticulum*, but moſt frequently *Omentum*. See Anatomy *Index.*

Caul is likewiſe a little membrane, found on ſome children, encompaſſing the head when born.

Drelincourt takes the *caul* to be only a fragment of the membranes of the fœtus: which ordinarily break at the birth of the child. Lampridius tells us, that the midwives ſold this *caul* at a good price to the advocates and pleaders of his time; it being an opinion, that while they had this about them, they ſhould carry with them a force of perſuaſion which no judge could withſtand: the canons forbid the uſe of it; becauſe ſome witches and ſorcerers, it ſeems, had abuſed it.

CAULIFLOWERS, in *Gardening*, a much eſteemed ſpecies of cabbage. See Brassica.

CAURIS, in *Natural Hiſtory*, a name given by ſome to the genus of ſhells called, by the generality of writers, *porcellana* and *concha venerea.* It is from a falſe pronunciation of this word *cauris* that theſe ſhells are called *cowries.* See *Porcelain-Shell*, Conchology *Index.*

CAURSINES (*Caurſini*), were Italians that came into England about the year 1235, terming themſelves *the Pope's merchants*, but driving no other trade than letting out money; and having great banks in England, they differed little from Jews, ſave (as hiſtory ſays) they were rather more mercileſs to their debtors. Some will have them called *Courſines*, quaſi *Cauſa Urſini*, beariſh, or cruel in their cauſes; others *Caorſini* or *Corſini*, as coming from the iſle of Corſica: but Cowel ſays, they have their name from *Caorſium*, *Caorſi*, a town in Lombardy, where they firſt practiſed their arts of uſury and extortion; from whence ſpreading themſelves, they carried their infamous trade through moſt parts of Europe, and were a common plague to every nation where they came. The then biſhop of London excommunicated them; and King Henry III. baniſhed them from this kingdom in the year 1240. But, being the pope's ſolicitors and money changers, they were permitted to return in the year 1250; tho' in a very ſhort time they were again driven out of the kingdom on account of their intolerable exactions.

CAUSA matrimonii prælocuti, in common law, a writ that lies where a woman gives land to a man in fee to the intent he ſhall marry her, and he refuſes to do it in a reaſonable time, being thereupon required by the woman; and in ſuch caſe, for not performing the condition, the entry of the woman into the lands again has been adjudged lawful.

The huſband and wife may ſue this writ againſt another who ought to have married her.

CAUSALITY, among metaphyſicians, the action or power of a cauſe in producing its effect.

CAUSALTY, among miners, denotes the lighter, ſulphureous, earthy parts of ores, carried off in the operation of waſhing. This, in the mines, they throw in heaps upon banks, which in ſix or ſeven years they find it worth their while to work over again.

CAUSE, that from whence any thing proceeds, or by virtue of which any thing is done: it ſtands oppoſed to effect. We get the ideas of cauſe and effect from our obſervation of the viciſſitude of things, while we perceive ſome qualities or ſubſtances begin to exiſt, and that they receive their exiſtence from the due application and operation of other beings. That which produces, is the cauſe; and that which is produced, the effect: thus, fluidity in wax is the effect of a certain degree of heat, which we obſerve to be conſtantly produced by the application of ſuch heat.

Ariſtotle, and the ſchoolmen after him, diſtinguiſhed four kinds of cauſes; the efficient, the material, the formal, and the final. This, like many of Ariſtotle's diſtinctions, is only a diſtinction of the various meanings of an ambiguous word: for the efficient, the matter, the form, and the end, have nothing common in their nature, by which they may be accounted ſpecies of the ſame *genus*; but the Greek word, which we

Reid on the Active Powers of Man.

tranſlate *cauſe*, had theſe four different meanings in Ariſtotle's days, and we have added other meanings. We do not indeed call the matter or the form of a thing its cauſe; but we have final cauſes, inſtrumental cauſes, occaſional cauſes, and many others. Thus the word cauſe has been ſo hackneyed, and made to have ſo many different meanings in the writings of philoſophers, and in the diſcourſe of the vulgar, that its original and proper meaning is loſt in the crowd.

With regard to the phenomena of nature, the important end of knowing their cauſes, beſides gratifying our curioſity, is, that we may know when to expect them, or how to bring them about. This is very often of real importance in life; and this purpoſe is ſerved, by knowing what, by the courſe of nature, goes before them and is connected with them; and this, therefore, we call the *cauſe* of ſuch a phenomenon.

If a magnet be brought near to a mariner's compaſs, the needle, which was before at reſt, immediately begins to move, and bends its courſe towards the magnet, or perhaps the contrary way. If an unlearned ſailor is aſked the cauſe of this motion of the needle, he is at no loſs for an anſwer. He tells you it is the magnet; and the proof is clear: for, remove the magnet, and the effect ceaſes; bring it near, and the effect is again produced. It is, therefore, evident to ſenſe, that the magnet is the cauſe of this effect.

A Carteſian philoſopher enters deeper into the cauſe of this phenomenon. He obſerves, that the magnet does not touch the needle, and therefore can give it no impulſe. He pities the ignorance of the ſailor. The effect is produced, ſays he, by magnetic effluvia, or ſubtle matter, which paſſes from the magnet to the needle, and forces it from its place. He can even ſhow you, in a figure, where theſe magnetic effluvia iſſue from the magnet, what round they take, and what way they return home again. And thus he thinks he comprehends perfectly how, and by what cauſe, the motion of the needle is produced.

A Newtonian philoſopher inquires what proof can be offered for the exiſtence of magnetic effluvia, and can find none. He therefore holds it as a fiction, a hypotheſis; and he has learned that hypotheſis ought to have no place in the philoſophy of nature. He confeſſes his ignorance of the real cauſe of this motion, and thinks that his buſineſs as a philoſopher is only to find from experiment the laws by which it is regulated in all caſes.

Theſe three perſons differ much in their ſentiments with regard to the real cauſe of this phenomenon; and the man who knows moſt is he who is ſenſible that he knows nothing of the matter. Yet all the three ſpeak the ſame language, and acknowledge that the cauſe of this motion is the attractive or repulſive power of the magnet.

What has been ſaid of this, may be applied to every phenomenon that falls within the compaſs of natural philoſophy. We deceive ourſelves, if we conceive that we can point out the real efficient cauſe of any one of them.

The grandeſt diſcovery ever made in natural philoſophy, was that of the law of gravitation, which opens ſuch a view of our planetary ſyſtem, that it looks like ſomething divine. But the author of this diſcovery was perfectly aware that he diſcovered no real cauſe, but only the law or rule according to which the unknown cauſe operates.

Natural philoſophers, who think accurately, have a preciſe meaning to the terms they uſe in the ſcience; and when they pretend to ſhow the cauſe of any phenomenon of nature, they mean by the cauſe, a law of nature of which that phenomenon is a neceſſary conſequence.

The whole object of natural philoſophy, as Newton expreſsly teaches, is reducible to theſe two heads: firſt, by juſt induction from experiment and obſervation, to diſcover the laws of nature; and then to apply thoſe laws to the ſolution of the phenomena of nature. This was all that this great philoſopher attempted, and all that he thought attainable. And this indeed he attained in a great meaſure, with regard to the motions of our planetary ſyſtem, and with regard to the rays of light.

But ſuppoſing that all the phenomena which fall within the reach of our ſenſes were accounted for from general laws of nature juſtly deduced from experience; that is, ſuppoſing natural philoſophy brought to its utmoſt perfection; it does not diſcover the efficient cauſe of any one phenomenon in nature.

The laws of nature are the rules according to which the effects are produced; but there muſt be a cauſe which operates according to theſe rules. The rules of navigation never navigated a ſhip. The rules of architecture never built a houſe.

Natural philoſophers, by great attention to the courſe of nature, have diſcovered many of her laws, and have very happily applied them to account for many phenomena: but they have never diſcovered the efficient cauſe of any one phenomenon; nor do thoſe who have diſtinct notions of the principles of the ſcience make any ſuch pretence.

Upon the theatre of nature we ſee innumerable effects which require an agent endowed with active power; but the agent is behind the ſcene. Whether it be the Supreme cauſe alone, or a ſubordinate cauſe or cauſes; and if ſubordinate cauſes be employed by the Almighty, what their nature, their number, and their different offices may be; are things hid, for wiſe reaſons, without doubt, from the human eye.

Cause, among civilians, the ſame with action. See Action.

Cause, among phyſicians. The cauſe of a diſeaſe is defined by Galen to be that during the preſence of which we are ill, and which being removed, the diſorder immediately ceaſes. The doctrine of the cauſes of diſeaſes is called Etiology.

Phyſicians divide cauſes into procatarctic, antecedent, and continent.

Procatarctic Cause, (αιτια προκαταρκτικη), called alſo *primitive* and *incipient cauſe*, is either an occaſion which of its own nature does not beget a diſeaſe, but happening on a body inclined to diſeaſes breeds a fever, gout, &c. (ſuch as are watching, faſting, and the like); or an evident and manifeſt cauſe, which immediately produces the diſeaſe, as being ſufficient thereto, ſuch as is a ſword in reſpect of a wound.

Antecedent Cause, (αιτια προηγουμενη), a latent diſpoſition of the body, from whence ſome diſeaſe may ariſe; ſuch as a plethora in reſpect of a fever, a cacochymia in reſpect of a ſcurvy.

Continent, *Conjunct*, or *Proximate* CAUSE, that principle in the body which immediately adheres to the diſeaſe, and which being preſent, the diſeaſe is alſo preſent; or, which being removed, the diſeaſe is taken away: ſuch is the ſtone in a nephritic patient.

CAUSEWAY, or CAUSEY, a maſſive conſtruction of ſtones, ſtakes, and faſcines; or an elevation of fat viſcous earth, well beaten; ſerving either as a road in wet marſhy places, or as a mole to retain the waters of a pond, or prevent a river from overflowing the lower grounds. See ROAD.—The word comes from the French *chauſſée*, anciently wrote *chaulſée*; and that from the Latin *calceata*, or *calcata*; according to Somner and Spelman, *à calcando*. Bergier rather takes the word to have had its riſe *à peditum calceis, quibus teruntur*. Some derive it from the Latin *calx*, or French *chaux*, as ſuppoſing it primarily to denote a way paved with chalk ſtones.

CAUSEWAY, (*calcetum* or *calcea*), more uſually denotes a common hard raiſed way, maintained and repaired with ſtones and rubbiſh.

Devil's CAUSEWAY, a famous work of this kind, which ranges through the county of Northumberland, commonly ſuppoſed to be Roman, though Mr Horſley ſuſpects it to be of later times.

Giant's CAUSEWAY, is a denomination given to a huge pile of ſtony columns in the diſtrict of Coleraine in Ireland. See *GIANT's Cauſeway*.

CAUSSIN, NICHOLAS, ſurnamed the Juſt, a French Jeſuit, was born at Troyes in Champagne, in the year 1580; and entered into the Jeſuits order when he was 26 years of age. He taught rhetoric in ſeveral of their colleges, and afterwards began to preach, by which he gained very great reputation. He increaſed this reputation by publiſhing books, and in time was preferred to be confeſſor to the king. But he did not diſcharge this office to the ſatisfaction of Cardinal Richelieu, though he diſcharged it to the ſatisfaction of every honeſt man; and therefore it is not to be wondered at that he came at length to be removed. He died in the Jeſuits convent at Paris in 1651. None of his works did him more honour than that which he entitled *La Cour Sainte*. It has been printed a great many times; and tranſlated into Latin, Italian, Spaniſh, Portugueſe, German, and Engliſh. He publiſhed ſeveral other books both in Latin and French.

CAUSTICITY, a quality belonging to ſeveral ſubſtances, by the acrimony of which the parts of living animals may be corroded and deſtroyed. Bodies which have this quality, when taken internally, are true poiſons. The cauſticity of ſome of theſe, as of arſenic, is ſo deadly, that even their external uſe is proſcribed by prudent phyſicians. Several others, as nitrous acid, lapis infernalis, or lunar cauſtic, common cauſtic, butter of antimony, are daily and ſucceſsfully uſed to conſume fungous fleſh, to open iſſues, &c. They ſucceed very well when properly employed and ſkilfully managed.

The cauſticity of bodies depends entirely on the ſtate of the ſaline, and chiefly of the acid, matters they contain. When theſe acids happen to be at the ſame time much concentrated, and ſlightly attached to the matters with which they are combined, they are then capable of acting, and are corroſive or cauſtic. Thus fixed and volatile alkalies, although they are themſelves cauſtic, become much more ſo by being treated with quicklime; becauſe this ſubſtance deprives them of all their fixed air, or carbonic acid to which they owe their mildneſs. By this treatment, then, the ſaline principle is more diſengaged, and rendered more capable of action. Alſo all combinations of metallic matters with acids form ſalts more or leſs corroſive, becauſe theſe acids are deprived of all their ſuperabundant water, and are beſides but imperfectly ſaturated with the metallic matters. Nevertheleſs, ſome other circumſtance is neceſſary to conſtitute the cauſticity of theſe ſaline metalline matters. For the ſame quantity of marine acid, which, when pure and diluted with a certain quantity of water, would be productive of no harm, ſhall, however, produce all the effects of a corroſive poiſon, when it is united with mercury in *corroſive ſublimate*, although the ſublimate ſhall be diſſolved in ſo much water that its cauſticity cannot be attributed to the concentration of its acid. This effect is, by ſome chemiſts, attributed to the great weight of the metallic matters with which the acid is united; and this opinion is very probable, ſeeing its cauſticity is nothing but its diſſolving power, or its diſpoſition to combine with other bodies; and this diſpoſition is nothing elſe than attraction.

On this ſubject Dr Black obſerves, that the compounds produced by the union of the metals with acids are in general corroſive. Many of them applied to the ſkin deſtroy it almoſt as faſt as the mineral acids; and ſome of the moſt powerful potential cauteries are made in this way. Some are reckoned more acrid than the pure acids themſelves; and they have more powerful effects when taken internally, or at leaſt ſeem to have. Thus we can take 10 or 12 drops of a foſſil acid, diluted with water, without being diſturbed by it; but the ſame quantity of acid previouſly combined with ſilver, quickſilver, copper, or regulus of antimony, will throw the body into violent diſorders, or even prove a poiſon, if taken all at once.

This increaſed activity was, by the mechanical philoſophers, ſuppoſed to ariſe from the weight of the metallic particles. They imagined that the acid was compoſed of minute particles of the ſhape of needles or wedges; by which means they were capable of entering the pores of other bodies, ſeparating their atoms from each other, and thus diſſolving them. To theſe acid ſpiculæ the metallic particles gave more force; and the momentum of each particular needle or wedge was increaſed in proportion to its increaſe of gravity by the additional weight of the metallic particle. But this theory is entirely fanciful, and does not correſpond with facts. The activity of the compound is not in proportion to the weight of the metal; nor are the compounds always poſſeſſed of any great degree of acrimony: neither is it true that any of them have a greater power of deſtroying animal ſubſtances than the pure acids have.

There is a material difference between the powers called *ſtimuli* and *corroſives*. Let a perſon apply to any part of the ſkin a ſmall quantity of lunar cauſtic, and likewiſe a drop of ſtrong nitrous acid, and he will find that the acid acts with more violence than the cauſtic; and the diſorders that are occaſioned by the compounds of metals and acids do not proceed from a *cauſticity* in them, but from the metal affecting and proving a ſtimulus to the nerves: and that this is the caſe, appears from their affecting ſome particular nerves of the body. Thus the compounds of antimony and mercury with the vegetable acids, do not ſhow the ſmalleſt degree of acrimony; but, taken internally, they produce violent convulſive motions over the whole body, which are occaſioned by the metallic matter having a power of producing this effect; and the acid is only the means of bringing it into a diſſolved ſtate, and making it capable of acting on the nervous ſyſtem. In general, however, the compounds of metallic ſubſtances with acids may be conſidered as milder than the acids in a ſeparate ſtate; but the acid is not ſo much neutralized as in other compounds, for it is leſs powerfully attracted by the metal; ſo that alkaline ſalts, abſorbent earths, or even heat alone, will decompound them; and ſome of the inflammable ſubſtances, as ſpirit of wine, aromatic oils, &c. will attract the acid, and precipitate the metal in its metallic form: and the metals can be employed to precipitate one another in their metallic form; ſo that the coheſion of theſe compounds is much weaker than thoſe formed of the ſame acids with alkaline ſalts or earths.

CAUSTICS, is an appellation given to ſubſtances of ſo hot and fiery a nature, that, being applied, conſume, and as it were burn, the texture of the parts, like hot iron.

Cauſtics are generally divided into four ſorts; the common ſtronger cauſtic, the common milder cauſtic, the antimonial cauſtic, and the lunar cauſtic. See Pharmacy and Chemistry *Index*.

Caustic Curve, in the higher geometry, a curve formed by the concourſe or coincidence of the rays of light reflected from ſome other curve.

CAUSUS, or Burning Fever, a ſpecies of continual fever, accompanied with a remarkable inflammation of the blood.

CAUTERIZATION, the act of burning or ſearing ſome morbid part, by the application of fire either actual or potential. In ſome places they cauterize with burning tow, in others with cotton or moxa, in others with live coals; ſome uſe Spaniſh wax, others pyramidal pieces of linen, others gold or ſilver; Severinus recommends flame blown through a pipe; but what is uſually preferred among us is a hot iron.

Cauterizing irons are of various figures; ſome flat, others round, ſome curved, &c. of all which we find draughts in Albucaſis, Scultetus, Ferrara, and others. Sometimes a cautery is applied through a capſula, to prevent any terror from the ſight of it. This method was invented by Placentinus, and is deſcribed by Scultetus. In the uſe of all cauteries, care is to be taken to defend the neighbouring parts, either by a lamina, defenſive plaſter, or lint moiſtened in oxycrate. Sometimes the hot iron is tranſmitted through a copper cannula, for the greater ſafety of the adjoining parts. The degrees and manners of cauterizing are varied according to the nature of the diſeaſe and the part affected.

CAUTERY, in *Surgery*, a medicine for burning, eating, or corroding any ſolid part of the body.

Cauteries are diſtinguiſhed into two claſſes; actual and potential: by actual cauteries are underſtood red hot inſtruments, uſually of iron; and by potential cauteries are underſtood certain kinds of corroding medicines. See Pharmacy.

CAUTION, in the *Civil* and *Scots Law*, denotes much the ſame with what, in the law of England, is called Bail.

CAUTIONER, in *Scots Law*, that perſon who becomes bound for another to the peformance of any deed or obligation. As to the different kinds and effects of Cautionry, ſee Law, Part III. N° clxxv. 19.

CAWK. See Cack.

CAXA, a little coin made of lead mixed with ſome ſcoria of copper, ſtruck in China, but current chiefly at Bantam in the iſland of Java, and ſome of the neighbouring iſlands. See (the *Table* ſubjoined to) Money.

CAXAMALCA, the name of a town and diſtrict of Peru in South America, where there was a moſt ſumptuous palace belonging to the Incas, and a magnificent temple dedicated to the ſun.

CAXTON, William, a mercer of London, eminent by the works he publiſhed, and for being *reputed* the firſt who introduced and practiſed the art of printing in England; as to which, ſee *(the Hiſtory of)* Printing

CAYENNE, a rich town and iſland of South America, and capital of the French ſettlements there, is bounded on the north by the Dutch colonies of Surinam, and ſituated in W. Long. 53. 10. N. Lat. 50.

This ſettlement was begun in 1645. A report had prevailed for ſome time before, that in the interior parts of Guiana, there was a country known by the name of *El Dorado*, which contained immenſe riches in gold and precious ſtones; more than ever Cortez and Pizarro had found in Mexico and Peru; and this fable had fired the imagination of every nation in Europe. It is ſuppoſed that this was the country in queſt of which Sir Walter Raleigh went on his laſt voyage; and as the French were not behind their neighbours in their endeavours to find out ſo deſirable a country, ſome attempts for this purpoſe were likewiſe made by that nation much about the ſame time; which at laſt coming to nothing, the adventurers took up their reſidence on the iſland of Cayenne. In 1643, ſome merchants of Rouen united their ſtock, with a deſign to ſupport the new colony; but, committing their affairs to one Poncet de Bretigny, a man of a ferocious diſpoſition, he declared war both againſt the coloniſts and ſavages, in conſequence of which he was ſoon maſſacred. This cataſtrophe entirely extinguiſhed the ardour of theſe aſſociates; and in 1651 a new company was eſtabliſhed. This promiſed to be much more conſiderable than the former; and they ſet out with ſuch a capital as enabled them to collect 700 or 800 coloniſts in the city of Paris itſelf. Theſe embarked on the Seine, in order to ſail down to Havre de Grace; but unfortunately the Abbé de Marivault, a man of great virtue, and the principal promoter of the undertaking, was drowned as he was ſtepping into his boat. Another gentleman, who was to have acted as general, was aſſaſſinated on his paſſage, and 12 of the principal adventurers who had promiſed to put the colony into a flouriſhing ſituation, not only were the principal perpetrators of this fact, but uniformly behaved in the ſame atrocious manner. At laſt they hanged one of their own number; two died; three were baniſhed to a deſert iſland; and the reſt abandoned themſelves to every kind of exceſs. The commandant of the citadel deſerted to the Dutch with part of his garriſon. The ſavages, rouſed by numberleſs provocations, fell upon the remainder: ſo that the few who were left thought themſelves happy in eſcaping to the Leeward Iſlands in a boat and two canoes, abandoning the fort, ammunition, arms, and merchandiſe, fifteen months after they had landed on the iſland.

In 1663, a new company was formed, whoſe capital amounted only to 8750l. By the aſſiſtance of the miniſtry they expelled the Dutch who had taken poſſeſſion of the iſland, and ſettled themſelves much more comfortably than their predeceſſors. In 1667 the iſland was taken by the Engliſh, and in 1676 by the Dutch, but afterwards reſtored to the French: and ſince that time it has never been attacked. Soon after ſome pirates, laden with the ſpoils they had gathered in the South ſeas, came and fixed their reſidence at Cayenne; reſolving to employ the treaſures they had acquired in the cultivation of the lands. In 1688, Ducaſſe, an able ſeaman, arrived with ſome ſhips from France, and propoſed to them the plundering of Surinam. This propoſal exciting their natural turn for plunder, the pirates betook themſelves to their old trade, and almoſt all the reſt followed their example. The expedition, however, proved unfortunate. Many of the aſſailants were killed, and all the reſt taken priſoners and ſent to the Carribee iſlands. This loſs the colony has never yet recovered.

The iſland of Cayenne is about 16 leagues in circumference, and is only parted from the continent by two rivers. By a particular formation, uncommon in iſlands, the land is higher near the water ſide, and low in the middle. Hence the land is ſo full of moraſſes, that all communication betwen the different parts of it is impoſſible, without taking a great circuit. There are ſome ſmall tracts of an excellent ſoil to be found here and there; but the generality is dry, ſandy, and ſoon exhauſted. The only town in the colony is defended by a covert way, a large ditch, a very good mud rampart, and five baſtions. In the middle of the town is a pretty conſiderable eminence, of which a redoubt has been made that is called the *fort*. The entrance into the harbour is through a narrow channel; and ſhips can only get in at high water, through the rocks and reefs that are ſcattered about this paſs.

The firſt produce of Cayenne was the arnotto; from the culture of which the coloniſts proceeded to that of cotton, indigo, and laſtly ſugar. It was the firſt of all the French colonies that attempted to cultivate coffee. The coffee tree was brought from Surinam in 1721 by ſome deſerters from Cayenne, who purchaſed their pardon by ſo doing. Ten or twelve years after they planted cocoa. In the year 1752 there were exported from Cayenne 260,541 pounds of arnotto, 80,363 pounds of ſugar, 17,919 pounds of cotton, 26,881 pounds of coffee, 91,916 pounds of cocao, 618 trees for timber, and 104 planks.

CAYLUS, Count de, Marquis de Sternay, Baron de Bronſac, was born at Paris in 1692. He was the eldeſt of the two ſons of John Count de Caylus, lieutenant general of the armies of the king of France, and of the marchioneſs de Villette. The count and counteſs, his father and mother, were very careful of the education of their ſon. The former inſtructed him in the profeſſion of arms, and in bodily exerciſes; the latter watched over and foſtered the virtues of his mind, and this delicate taſk ſhe diſcharged with ſingular ſucceſs. The counteſs was the niece of Madame de Maintenon, and was remarkable both for the ſolidity of her underſtanding and the charms of her wit. She was the author of that agreeable book entitled "The Recollections of Madame de Caylus," of which Voltaire lately publiſhed an elegant edition. The amiable qualities of the mother appeared in the ſon; but they appeared with a bold and military air. In his natural temper he was gay and ſprightly, had a taſte for pleaſure, a ſtrong paſſion for independence, and an invincible averſion to the ſervitude of a court. Such were the inſtructors of the Count de Caylus. He was only twelve years of age when his father died at Bruſſels in 1704. After finiſhing his exerciſes, he entered into the corps of the *Muſquetoires*; and in his firſt campaign in the year 1709, he diſtinguiſhed himſelf by his valour in ſuch a manner, that Louis XIV. commended him before all the court, and rewarded him with an enſigncy in the *Gendarmerie*. In 1711 he commanded a regiment of dragoons, which was called by his own name; and he ſignalized himſelf at the head of it in Catalonia. In 1713, he was at the ſiege of Fribourg, where he was expoſed to imminent danger in the bloody attack of the covered way. The peace of Raſtadt having left him in a ſtate of inactivity ill ſuited to his natural temper, his vivacity ſoon carried him to travel into Italy; and his curioſity was greatly excited by the wonders of that country, where antiquity is ſtill fruitful, and produces ſo many objects to improve taſte and to excite admiration. The eyes of the count were not yet learned; but he was ſtruck with the ſight of ſo many beauties, and ſoon became acquainted with them. After a year's abſence, he returned to Paris with ſo ſtrong a paſſion for travelling and for antiquities, as induced him to quit the army.

He had no ſooner quitted the ſervice of Louis, than he ſought for an opportunity to ſet out for the Levant. When he arrived at Smyrna, he viſited the ruins of Epheſus. From the Levant he was recalled in February 1717 by the tenderneſs of his mother. From that time he left not France, but to make two excurſions to London. The Academy of Painting and Sculpture adopted him an honorary member in the year 1731; and the count, who loved to realize titles, ſpared neither his labour, nor his credit, nor his fortune, to inſtruct, aſſiſt, and animate the artiſts. He wrote the lives of the moſt celebrated painters and engravers that have done honour to this illuſtrious academy; and, in order to extend the limits of the art, which ſeemed to him to move in two narrow a circle, he collected, in three different works, new ſubjects for the painter, which he had met with in the works of the ancients.

Such was his paſſion for antiquity, that he wiſhed to have had it in his power, to bring the whole of it to life again. He ſaw with regret, that the works of the ancient painters, which have been diſcovered in our times, are effaced and deſtroyed almoſt as ſoon as they are drawn from the ſubterraneous manſions where they were buried. A fortunate accident furniſhed him with the means of ſhowing us the compoſition and the colouring of the pictures of ancient Rome. The coloured drawing which the famous Pietro Sante Bartoli had taken there from antique pictures, fell into his hands. He had them engraved; and, before he enriched the king of France's cabinet with them, he gave an edition of them at his own expence. It is perhaps the moſt extraordinary book of antiquities that ever will appear. The whole is painted with a purity and a preciſion that are inimitable; we ſee the livelineſs and the freſhneſs of the colouring that charmed the Cæſars. There were only 30 copies publiſhed; and there is no reaſon to expect that there will hereafter be any more.

Count de Caylus was engaged at the ſame time in an enterpriſe ſtill more favourable to Roman grandeur, and more intereſting to the French nation. Colbert had framed the deſign of engraving the Roman antiquities that are ſtill to be ſeen in the ſouthern provinces of France. By his orders Mignard the architect had made drawings of them, which Count de Caylus had the good fortune to recover. He reſolved to finiſh the work begun by Colbert, and to dedicate it to that great miniſter; and ſo much had he this enterpriſe at heart, that he was employed in it during his laſt illneſs, and warmly recommended it to M. Mariette.

In 1742, Count Caylus was admitted honorary member of the Academy of Belles Lettres; and then it was that he ſeemed to have found the place for which nature deſigned him. The ſtudy of literature now became his ruling paſſion; he conſecrated to it his time and his fortune; he even renounced his pleaſures to give himſelf wholly up to that of making ſome diſcovery in the field of antiquity. But amidſt the fruits of his reſearch and invention, nothing ſeemed more flattering to him than his diſcovery of encauſtic painting. A deſcription of Pliny's, but too conciſe a one to give him a clear view of the matter, ſuggeſted the idea of it. He availed himſelf of the friendſhip and ſkill of M. Magault, a phyſician in Paris, and an excellent chemiſt; and by repeated experiments found out the ſecret of incorporating wax with divers tints and colours, and of making it odedient to the pencil. Pliny has made mention of two kinds of encauſtic painting practiſed by the ancients; one of which was performed with wax, and the other upon ivory, with hot punches of iron. It was the former that Count Caylus had the merit of reviving; and M. Muntz afterwards made many experiments to carry it to perfection.

In the hands of Count Caylus, literature and the arts lent each other a mutual aid. But it would be endleſs to give an account of all his works. He publiſhed above 40 diſſertations in the Memoirs of the Academy of Belles Lettres. The artiſts he was particularly attentive to; and to prevent their falling into miſtakes from an ignorance of coſtume, which the ableſt of them have ſometimes done, he founded a prize of 500 livres, the object of which is to explain, by means of authors and monuments, the uſages of ancient nations. In order that he might enjoy with the whole world the treaſures he had collected, he cauſed them to be engraved, and gave a learned deſcription of them in a work which he embelliſhed with 800 copperplates.

The ſtrength of his conſtitution ſeemed to give him hopes of a long life; but a humour ſettling in one of his legs, which entirely deſtroyed his health, he expired on the 5th of September 1765, and by his death his family is extinct. The tomb erected to the honour of Count Caylus is to be ſeen in the chapel of St Germain l'Auxerrois, and deſerves to be remarked. It is perfectly the tomb of an antiquary. This monument was an ancient ſepulchral antique, of the moſt beautiful porphyry, with ornaments in the Egyptian taſte. From the moment he procured it, he had deſtined it to grace the place of his interment. While he awaited the fatal hour, he placed it in his garden, where he uſed to look upon it with a tranquil but thoughtful eye, and pointed it out to the inſpection of his friends,

The character of Count Caylus is to be traced in the different occupations which divided his cares and his life. In ſociety, he had all the frankneſs of a ſoldier, and a politeneſs which had nothing in it of deceit or circumvention. Born independent, he applied to ſtudies which ſuited his taſte. His heart was yet better than his abilities. In his walks he uſed frequently to try the honeſty of the poor, by ſending them with a piece of money to get change for him. In theſe caſes he enjoyed their confuſion at not finding him; and then preſenting himſelf, uſed to commend their honeſty, and give them double the ſum. He ſaid frequently to his friends, "I have this day loſt a crown; but I was ſorry that I had not an opportunity of giving a ſecond. The beggar ought not to want integrity."

CAYSTER, or Caystrus, in *Ancient Geography*, a river of Ionia, whoſe mouth Ptolemy places between Colophon and Epheſus; commended by the poets for its ſwans, which it had in great numbers. Its ſource was in the Montes Cilbiani, (Pliny). *Cayſtrius Campus* was a part of the territory of Epheſus. *Campi Cayſtriani* of Lydia were plains lying in the middle between the inland parts and Mount Tmolus.

CAZEROM, or Cazeron, a city of Aſia, in Perſia, ſituated in E. Long. 70. N. Lat. 29. 15.

CAZIC, or Cazique, a title given by the Spaniards to the petty kings, princes, and chiefs, of the ſeveral countries of America, excepting thoſe of Peru, which are called *curatas*. The French call them *caſiques*, a denomination which they always give to the Tartarian hordes.—The cazics, in ſome places, do the office of phyſicians, and in others of prieſts, as well as of captains. The dignity of cazic among the Chiites, a people of South America, does not deſcend to children, but muſt be acquired by valour and merit. One of the prerogatives attached to it is, that the cazic may have three wives, while the other people are allowed only one. Mexico comprehended a great number of provinces and iſlands, which were governed by lords called *caziques*, dependent on and tributary to the emperor. Thirty of theſe vaſſals are ſaid to have been ſo powerful, that they were able, each of them, to bring an army of 100,000 men into the field.

CAZIMIR, a handſome town of Poland, in the palatinate of Lublin, ſituated on a hill covered with trees, in E. Long. 3. 10. N. Lat. 51. 5.

CEA. See Ceos.

CEANOTHUS, New-Jersey Tea. See Botany *Index*.

Cebes, Cecil.

CEBES, of Thebes, a Socratic philoſopher, author of the admired *Table of Cebes*; or, "Dialogues on the Birth, Life, and Death of Mankind." He flouriſhed about 405 years before Chriſt.—The above piece is mentioned by ſome of the ancient writers, by Lucian, D. Laertius, Tertullian, and Suidas: but of Cebes himſelf we have no account, ſave that he is once mentioned by Plato, and once by Xenophon. The former ſays of him, in his "Phædo," that he was a ſagacious inveſtigator of truth, and never aſſented without the moſt convincing reaſons: the latter, in this "Memorabilia," ranks him among the few intimates of Socrates, who excelled the reſt in the innocency of their lives. Cebes's *Tabula* is uſually printed with Epictetus's *Manuale*.

CECIL, William, Lord Burleigh, treaſurer of England in the reign of Queen Elizabeth, was the ſon of Richard Cecil, Eſq; maſter of the robes to King Henry VIII. He was born in the houſe of his grandfather, David Cecil, Eſq; at Bourn in Lincolnſhire, in the year 1520; and received the rudiments of his education in the grammar-ſchool at Grantham. From thence he was removed to Stamford; and about the year 1535, was entered of St John's College, Cambridge. Here he began his ſtudies with a degree of enthuſiaſtic application very uncommon in young gentlemen of family. At the age of 16 he read a ſophiſtry lecture, and at 19 a voluntary Greek lecture, which was the more extraordinary as being at a time when the Greek language was by no means univerſally underſtood. In 1541 he went to London, and became a member of the ſociety of Gray's Inn, with an intention to ſtudy the law; but he had not been long in that ſituation before an accident introduced him to King Henry, and gave a new bias to his purſuits. O'Neil, a famous Iriſh chief, coming to court, had brought with him two Iriſh chaplains, violent bigots to the Romiſh faith; with theſe Mr Cecil, viſiting his father, happened to have a warm diſpute in Latin, in which he diſplayed uncommon abilities. The king, being informed of it, ordered the young man into his preſence, and was ſo pleaſed with his converſation, that he commanded his father to find a place for him. He accordingly requeſted the reverſion of the *cuſtos brevium*, which Mr Cecil afterwards poſſeſſed. About this time he married the ſiſter of Sir John Cheke, by whom he was recommended to the Earl of Hertford, afterwards duke of Somerſet and protector.

Soon after King Edward's acceſſion, Mr Cecil came into the poſſeſſion of the office of *cuſtos brevium*, worth about 240l. a-year. His firſt lady dying in 1543, he married the daughter of Sir Anthony Cook, director of the king's ſtudies. In 1547, he was appointed by the protector maſter of requeſts; and ſoon after attended his noble patron on his expedition againſt the Scots, and was preſent at the battle of Muſſelburgh. In this battle, which was fought on the 10th of September 1547, Mr Cecil's life was miraculouſly preſerved by a friend, who on puſhing him out of the level of a cannon, had his arm ſhattered to pieces. The ſight and judgment of his friend muſt have been as extraordinary as his friendſhip, to perceive the preciſe direction of a cannon ſhot; unleſs we ſuppoſe, that the ball was almoſt quite ſpent; in which caſe the thing is not impoſſible. The ſtory is told in his life by a domeſtic. In the year 1548, Mr Cecil was made ſecretary of ſtate; but in the following year, the duke of Northumberland's faction prevailing, he ſuffered in the diſgrace of the protector Somerſet, and was ſent priſoner to the tower. After three months confinement he was releaſed; in 1551 reſtored to his office; and ſoon after knighted, and ſworn of the privy council. In 1553 he was made chancellor of the order of the Garter, with an annual fee of 100 merks.

Cecil.

On the death of Edward VI. Mr Cecil prudently refuſed to have any concern in Northumberland's attempt in favour of the unfortunate Lady Jane Gray; and when Queen Mary acceded to the throne, he was graciouſly received at court; but not chooſing to change his religion, was diſmiſſed from his employments. During this reign, he was twice elected knight of the ſhire for the county of Lincoln; and often ſpoke in the houſe of commons with great freedom and firmneſs, in oppoſition to the miniſtry. Nevertheleſs, though a Proteſtant and a *patriot* (that is, a courtier out of place), he had the addreſs to ſteer through a very dangerous ſea without ſhipwreck.

Queen Elizabeth's acceſſion in the year 1558 immediately diſpelled the cloud which had obſcured his fortunes and miniſterial capacity. During the horrid reign of her ſiſter, he had conſtantly correſponded with the princeſs Elizabeth. On the very day of her acceſſion, he preſented her with a paper containing twelve articles neceſſary for her immediate diſpatch; and, in a few days after, was ſworn of the privy council, and made ſecretary of ſtate. His firſt advice to the queen was, to call a parliament; and the firſt buſineſs he propoſed after it was aſſembled was the eſtabliſhment of a national church. A plan of reformation was accordingly drawn up under his immediate inſpection, and the legal eſtabliſhment of the church of England was the conſequence. Sir William Cecil's next important concern, was to reſtore the value of the coin, which had in the preceding reigns been conſiderably debaſed. In 1561, he was appointed maſter of the wards; and, in 1571, created baron of Burleigh, as a reward for his ſervices, particularly in having lately ſtifled a formidable rebellion in the north. The following year he was honoured with the garter, and raiſed to the office of lord high treaſurer of England. From this period we find him the *primum mobile* of every material tranſaction during the glorious reign of Queen Elizabeth. Notwithſtanding the temporary influence of other favourites, Lord Burleigh was, in fact, her prime miniſter, and the perſon on whom ſhe chiefly confided in matters of real importance. Having filled the higheſt and moſt important offices of the ſtate for 40 years, and guided the helm of government during the moſt glorious period of Engliſh hiſtory, he departed this life on the 4th of Auguſt 1598, in the 78th year of his age. His body was removed to Stamford, and there depoſited in the family vault, where a magnificent tomb was erected to his memory.—Notwithſtanding his long enjoyment of ſuch lucrative employments, he left only an eſtate of 4000l. per annum, 11,000l. in money, and effects worth about 14,000l. He lived, indeed, in a manner ſuitable to his high rank and importance,

portance. He had four places of reſidence, viz. his lodgings at court, his houſe in the Strand, his ſeat at Burleigh Park near Stamford, and his ſeat at Theobald's. The laſt of theſe was his favourite place of retirement, where he frequently entertained the queen at a vaſt expence.

Lord Burleigh was doubtleſs a man of ſingular abilities and prudence, amiable in his private character, and one of the moſt able, upright, and indefatigable miniſters ever recorded in the annals of this kingdom. His principal works are, 1. *La Complainte de l'ame pechereſſe*, or the Complaint of a ſinful Soul, in French verſe, in the king's library. 2. Materials for Patten's *Diarium exped. Scoticæ*, London, 1541, 12mo. 3. Slanders and lies maliciouſly, groſsly, and impudently vomited out, in certain traiterous books and pamphlets, againſt two counſellors, Sir Francis Bacon and Sir William Cecil. 4. A ſpeech in parliament, 1562, Strype's Mem. vol. iv. p 107. 5. Precepts or directions for the well ordering of a man's life, 1637, Harl. Cat. vol ii. p. 755. 6 Meditations on the death of his lady, Ballard's Mem p. 184. 7. Meditations on the ſtate of England during the reign of Queen Elizabeth, manuſcript. 8. The execution of juſtice in England for the maintenance of public and Chriſtian peace, &c. Lond. 1581, 1583, Somer's tracts, 4th Collect. vol. i. p. 5. 9. Advice to Queen Elizabeth in matters of religion and ſtate, ib. p. 101, 106. 10. A great number of letters. See Peck's *Deſiderata Curioſa*, Howard's collections, &c. 11. Several pedigrees, ſome of which are preſerved in the arcqbiſhop of Canterbury's library at Lambeth, N° 299, 747.

CECILIA, St, the patroneſs of muſic, has been honoured as a martyr ever ſince the fifth century. Her ſtory, as delivered by the notaries of the Roman church, and from thence tranſcribed into the Golden Legend and other books of the like kind, ſays, that ſhe was a Roman lady, born of noble parents about the year 295: That, notwithſtanding ſhe had been converted to Chriſtianity, her parents married her to a young Pagan nobleman named Valerianus; who going to bed to her on the wedding night, *as the cuſtom is*, ſays the book, was given to underſtand by his ſpouſe, that ſhe was nightly viſited by an angel, and that he muſt forbear to approach her, otherwiſe the angel would deſtroy him. Valerianus, ſomewhat troubled at theſe words, deſired that he might ſee his rival the angel; but his ſpouſe told him that was impoſſible, unleſs he would conſent to be baptized and become a Chriſtian. This he conſented to; after which, returning to his wife, he found her in her cloſet at prayer, and by her ſide, in the ſhape of a beautiful young man, an angel clothed with brightneſs. After ſome converſation with the angel, Valerianus told him that he had a brother named Tiburtius, whom he greatly wiſhed to ſee a partaker of the grace which he himſelf had received The angel told him that his deſire was granted, and that they ſhould be both crowned with martyrdom in a ſhort time. Upon this the angel vaniſhed, and was not long in ſhowing himſelf as good as his word; Tiburtius was converted, and both he and his brother Valerianus were beheaded. Cecilia was offered her life upon condition that ſhe would ſacrifice to the deities of the Romans; but ſhe refuſed; upon which ſhe was thrown into a caldron of boiling water, and ſcalded to death. Others ſay, that ſhe was ſtifled in a dry bath, i e. an encloſure from whence the air was excluded, having a ſlow fire underneath it; which kind of death was ſometimes inflicted by the Romans upon women of quality who were criminals. Upon the ſpot where her houſe ſtood, is a church, ſaid to have been built by Pope Urban I. who adminiſtered baptiſm to her huſband and his brother: it is the church of St Cecilia at Traſtevere; within is a moſt curious painting of the ſaint, as alſo a ſtately monument with a cumbent ſtatue of her with her face downwards. There is a tradition of St Cecilia, that ſhe excelled in muſic; and that the angel who was thus enamoured of her, was drawn from the celeſtial regions by the charms of her melody: this has been deemed authority ſufficient to making her the patroneſs of muſic and muſicians. The legend of St Cecilia has given frequent occaſion to painters and ſculptors to exerciſe their genius in repreſentations of her, playing on the organ, and ſometimes on the harp. Raphael has painted her ſinging with a regal in her hands; and Domenichino and Mignard, ſinging and playing on the harp.

CECROPS, the founder and firſt king of Athens, about the time of Moſes the lawgiver of the Hebrews. He was the firſt who eſtabliſhed civil government, religious rites, and marriage among the Greeks; and died after a reign of 50 years. See ATTICA, N° 4.

CEDAR. See JUNIPERUS and PINUS, BOTANY *Index*.

The ſpecies of cedar famous for its duration, is that popularly called the cedar of Lebanon *(Pinus cedrus)*, by the ancients *cedrus magna*, or the great cedar: alſo *cedrelate*, κεδρελατη. See PINUS, BOTANY *Index*.

CEDRENUS, GEORGE, a Grecian monk, lived in the 11th age, and wrote, "Annals, or an abridged Hiſtory, from the beginning of the World to the Reign of Iſaac Comnenus emperor of Conſtantinople, who ſucceeded Michael IV. in 1057." This work is no more than an extract from ſeveral hiſtorians. There is an edition of it, printed at Paris in 1647, with tbe Latin verſion of Xylander, and the notes of Father Goar a Dominican.

CEDRUS, the CEDAR TREE, MAHOGANY, &c. See JUNIPERUS, PINUS, and SWIETENIA, BOTANY *Index*.

CEILING, in *Architecture*, the top or roof of a lower room; or a covering of plaſter over laths nailed on the bottom of the joiſts that bear the floor of the upper room; or where there is no upper room, on joiſts for the purpoſe; hence called *ceiling joiſts*. The word *ceiling* anſwers pretty accurately to the Latin *lacunar*, "every thing over head.'

Plaſtered ceilings are much uſed in Britain, more than any other country: nor are they without their advantages, as they make the room lightſome; are good in caſe of fire; ſtop the paſſage of the duſt; leſſen the noiſe over head; and, in ſummer, make the air cooler.

CEILING, in ſea language, denotes the inſide planks of a ſhip.

CEIMELIA, from κειμαι, "to be laid up," in antiquity, denotes choice or precious pieces of furniture or ornaments, reſerved or laid up for extraordinary occaſions and uſes; in which ſenſe, ſacred garments, veſſels, and the like, are reputed of the ceimelia of a church. Medals, antique ſtones, figures, manuſcripts, records, &c. are the ceimelia of men of letters.

CEIMELIARCHIUM, the repoſitory or place where ceimilia are preſerved.

CEIMELIOPHYLAX, (from κειμηλιον and φυλαττω *I keep*), the keeper or curator of a collection of ceimelia; ſometimes alſo denominated *ceimeliarcha*. The ceimeliarcha, or ceimeliophylax, was an officer in the ancient churches or monaſteries, anſwering to what was otherwiſe denominated *chartophylax*, and *cuſtos archivorum*.

CELÆNÆ, in *Ancient Geography*, the capital of Phrygia Magna, ſituated on a cognominal mountain, at the common ſources of the Mæander and Marſyas. The king of Perſia had a ſtrong place beneath the citadel, by the ſprings of the Marſyas, which roſe in the market-place, not leſs in ſize than the Mæander, and flowed through the city. Cyrus the younger had alſo a palace there, but by the ſprings of the Mæander, which river paſſed likewiſe through the city. He had, moreover, an extenſive paradiſe or park, full of wild beaſts, which he hunted on horſeback for exerciſe or amuſement; and watered by the Mæander, which ran through the middle. Xerxes was ſaid to have built theſe palaces and the citadel after his return from his expedition into Greece.

Antiochus Soter removed the inhabitants of Celænæ into a city which he named, from his mother, Apamea; and which became afterwards a mart inferior only to Epheſus. See APAMEA.

CELANDINE. See CHELIDONIUM, BOTANY *Index*.

CELANO, a town of Italy, in the kingdom of Naples, in Farther Abruzzo. It is ſeated a mile from the lake Celano, anciently called FUCINUS. E. Long. 13. 39. N. Lat. 41. 56.

CELARENT, among logicians, a mode of ſyllogiſm, wherein the major and concluſion are univerſal negative propoſitions, and the minor an univerſal affirmative.

E. gr. cE None whoſe underſtanding is limited can be omniſcient.
lA Every man's underſtanding is limited.
rEnt Therefore no man is omniſcient.

CELASTRUS. See BOTANY *Index*.

In Senegal the negroes uſe the powder of the root of this plant as a ſpecific againſt gonorrhœas, which it is ſaid to cure in eight or ſometimes in three days. An infuſion of the bark of a ſpecies of ſtaff treee, which grows in the iſle of France, is ſaid to poſſeſs the ſame virtues.

CELEBES, an iſland in the Indian ſea, ſituated under the equator, and called by ſome *Macaſſar*. The length and breadth have not been accurately computed; but the circumference, at a medium, is about 800 miles. It had formerly ſix kingdoms, which are reduced to one. The air is hot and moiſt, and ſubject to great rains during the north-weſt winds, which blow from November to March, at which time the country is overflowed, and for this reaſon they build their houſes on piles of wood ten feet high. The moſt healthful time is during the northern monſoons, which ſeldom fail blowing regularly in one part of the year. The chief vegetables are rice and cocoas; but they have ebony, ſanders, &c. Their fruits and flowers are much the ſame as in the neighbouring parts of the Indies. They have pepper, ſugar, betel, areca, the fineſt cotton, and opium. The natives have bright olive complexions, and the women have ſhining black hair. They are thought to be very handſome by the Dutch and Chineſe, who often purchaſe them for bedfellows. The men are induſtrious, robuſt, and make excellent ſoldiers. Their arms are ſabres, and trunks, from whence they blow poiſoned darts, which are pointed with the tooth of a ſea-fiſh. Some likewiſe uſe poiſoned daggers. They were the laſt of the Indian nations that were enſlaved by the Dutch, which could not be effected till after a long war. They teach their children to read and write, and their characters have ſome reſemblance of the Arabic. Their religion being Mahometan, the men indulge themſelves in many wives and concubines. The employment of the women is ſpinning, cookery, and making their own and their huſbands clothes. The men wear jewels in their ears, and the women gold chains about their necks. The inhabitants in general go half-naked, without any thing on their head, legs, or feet, and ſome have nothing but a cloth about their middle. The ſtreets of the town Macaſſar are ſpacious, and planted with trees on every ſide. It ſtands by the ſide of the only large river they have in the iſland. The Dutch have a fort here, mounted with 40 guns, and garriſoned with 700 men. There is only one other town of note, called *Jampandam*, where they alſo have a fort. The iſland is not near ſo populous as when the Dutch conquered it; the men being hired for ſoldiers in moſt of the neighbouring countries.

The religion of theſe iſlands was formerly idolatry. They worſhipped the ſun and moon. They ſacrificed to them in the public ſquares, having no materials which they thought valuable enough to be employed in raiſing temples. About two centuries ago, ſome Chriſtians and Mahometans having brought their opinions to Celebes, the principal king of the country took a diſlike to the national worſhip. Having convened a general aſſembly, he aſcended an eminence, when, ſpreading out his hands towards heaven, he told the Deity, that he would acknowledge for truth that doctrine whoſe miniſters ſhould firſt arrive in his dominions, and, as the winds and waves were at his command, the Almighty would have himſelf to blame if he embraced a falſehood. The aſſembly broke up, determined to wait the orders of heaven, and to obey the firſt miſſionaries that ſhould arrive. The Mahometans were the moſt active, and their religion accordingly prevailed.

CELERES, in Roman antiquity, a regiment of body-guards belonging to the Roman kings, eſtabliſhed by Romulus, and compoſed of 300 young men, choſen out of the moſt illuſtrious Roman families, and approved by the ſuffrages of the curiæ of the people, each of which furniſhed ten. The name comes from *celer*, "quick, ready;" and was given them becauſe of their promptneſs to obey the king.

The celeres always attended near the king's perſon, to guard him, to be ready to carry his orders, and to execute them. In war they made the van guard in the engagement, which they always began firſt; in retreats they made the rear-guard.

Though the celeres were a body of horſe, yet they uſually diſmounted, and fought on foot; their commander was called tribune, or prefect of the celeres. They were divided into three troops of 100 each, commanded by a captain called centurio: their tribune was the ſecond perſon in the kingdom.

Plutarch ſays, Numa broke the celeres. If this be true, they were ſoon re-eſtabliſhed; for we find them under moſt of the ſucceeding kings: witneſs the great Brutus, who expelled the Tarquins, and who was the tribune of the celeres.

CELERI, in *Botany*, the Engliſh name of a variety of the APIUM GRAVEOLENS.

The ſeed of celeri ſhould be ſown at two or three different times, the better to continue it for uſe through the whole ſeaſon without running up to ſeed. The firſt ſowing ſhould be in the beginning of March, upon a gentle hot-bed; the ſecond may be at the end of the ſame month, which ought to be in an open ſpot of light earth, where it may enjoy the benefit of the ſun; the third time of ſowing ſhould be in the latter end of April, or beginning of May, on a moiſt ſoil; and if expoſed to the morning ſun only, it will be ſo much the better, but it ſhould not be under the drip of trees. The middle of May, ſome of the plants of the firſt ſowing will be fit to tranſplant for blanching.

The manner of tranſplanting it is as follows: after having cleared the ground of weeds, you muſt dig a trench by a line about 10 inches wide, and 8 or 9 inches deep, looſening the earth in the bottom, and laying it level; and the earth that comes out of the trench ſhould be equally laid on each ſide the trench to be ready to draw in again to earth the celeri as it advances in height. Theſe trenches ſhould be made at three feet diſtance from each other; then plant your plants in the middle of the trench, at about four or five inches diſtance, in one ſtraight row, having before trimmed the plants, and cut off the tops of the long leaves: and as they are planted, you muſt obſerve to cloſe the earth well to their roots with your feet, and to water them plentifully until they have taken new root. As theſe plants advance in height, you muſt obſerve to draw the earth on each ſide cloſe to them, being careful not to bury their hearts, nor ever to do it but in dry weather; otherwiſe the plants will rot. When your plants have advanced a conſiderable height above the trenches, and all the earth, which was laid on the ſides thereof, hath been employed in earthing them up, you muſt then make uſe of a ſpade to dig up the earth between the trenches, which muſt alſo be made uſe of for the ſame purpoſe, continuing from time to time to earth it up until it is fit for uſe. The laſt crop ſhould be planted in a drier ſoil, to prevent its being rotted with too much wet in the winter. You will do well to cover your ridges of celeri with ſome peaſe-haulm, or ſome ſuch light covering, when the froſt is very hard, which will admit the air to the plants; for if they are covered too cloſe, they will be very ſubject to rot: by this means you will preſerve your celeri till ſpring; but you muſt remember to take off the covering whenever the weather will permit, otherwiſe it will be apt to cauſe the celeri to pipe and run to ſeed. The celeri, when full blanched, will not continue good above three weeks or a month before it will rot or pipe; therefore, in order to continue it good, you ſhould have at leaſt ſix or ſeven different ſeaſons of planting, proportioned to the conſumption.

The other ſort of celeri, which is commonly called *celeriac*, is to be managed in the ſame manner; excepting that this ſhould be planted on the level ground, or in very ſhallow drills: for this plant ſeldom grows above eight or ten inches high, ſo requires but little earthing up; the great excellency of this being in the ſize of the root, which is often as large as ordinary turnips.

The beſt method to ſave the ſeed of celeri, is to make choice of ſome long good roots of the upright celeri, which have not been too much blanched, and plant them out, at about a foot aſunder, in a moiſt ſoil, early in the ſpring; and when they run up to ſeed, keep them ſupported with ſtakes, to prevent their being broken down with the wind: and in July, when the ſeed begins to be formed, if the ſeaſon ſhould prove very dry, it will be proper to give ſome water to the plant, which will greatly help its producing good ſeeds. In Auguſt theſe ſeeds will be ripe, at which time it ſhould be cut up, in a dry time, and ſpread upon cloths in the ſun to dry; then beat out the ſeeds, and preſerve it in bags for uſe.

CELERI, *Wild*, (*Apium antarcticum*), was found in conſiderable quantities by Sir Joſeph Banks and Dr Solander on the coaſt of Terra del Fuego. It is like the garden celeri in the colour and diſpoſition of the flowers, but the leaves are of a deeper green. The taſte is between that of celeri and parſley. It is a very uſeful ingredient in the ſoup for ſeamen, becauſe of its antiſcorbutic quality.

CELERITY, in *Mechanics*, the ſwiftneſs of any body in motion. It is alſo defined to be an affection of motion, by which any moveable body runs through a given ſpace in a given time.

CELESTINS, a religious order ſo called from their founder Peter de Meuron, afterwards raiſed to the pontificate under the name of Celeſtin V. This Peter, who was born at Iſernia, a little town in the kingdom of Naples, in the year 1215, of but mean parents, retired, while very young, to a ſolitary mountain, in order to dedicate himſelf wholly to prayer and mortification. The fame of his piety brought ſeveral, out of curioſity, to ſee him; ſome of whom, charmed with his virtues, renounced the world to accompany him in his ſolitude. With theſe he formed a kind of community in the year 1254: which was approved by Pope Urban IV. in 1264, and erected into a diſtinct order, called the *hermits of St Damien*. Peter de Meuron governed this order till 1286, when his love of ſolitude and retirement induced him to quit the charge. In July 1294, the great reputation of his ſanctity raiſed him, though much againſt his will, to the pontificate. He then took the name of Celeſtin V. and his order that of *Celeſtins* from him. By his bull he approved their conſtitutions, and confirmed all their monaſteries to the number of 20. But he ſat too ſhort time in the chair of St Peter to do many great things for his order; for having governed the church five months and a few days, and conſidering the great burden he had taken upon him, to which he thought himſelf unequal, he ſolemnly renounced the pontificate in a conſiſtory held at Naples.

After his death, which happened in 1296, his order made great progreſs not only in Italy, but in France likewiſe: whither the then general Peter of Tivoli ſent 12 religious, at the requeſt of King Philip the Fair, who gave them two monaſteries; one in the foreſt of Orleans, and the other in the foreſt of Compeigne at Mount Chartres. This order likewiſe paſſed into ſeveral provinces of Germany. They have about 96 convents in Italy, and 21 in France, under the title of priories.

The Celeſtins riſe two hours after midnight to ſay matins. They eat no fleſh at any time, except when they are ſick. They faſt every Wedneſday and Friday, from Eaſter to the feaſt of the exaltation of the holy croſs; and, from that feaſt to Eaſter, every day. As to their habit, it conſiſts of a white gown, a capuche, and a black ſcapulary. In the choir, and when they go out of the monaſtery, they wear a black cowl with the capuche: their ſhirts are of ſerge.

CELETES, or Celetæ (from κελης, *a race-horſe)* in antiquity, denote ſingle or ſaddle-horſes, by way of contradiſtinction from thoſe yoked or harneſſed together, called *bigarii, quadrigarii,* &c. The ſame denomination is alſo given to the cavaliers or riders on horſeback; and hence ſome deduce celeres, the name of Romulus's guard.

CELEUSMA, or Celeuma, in antiquity, the ſhout or cry of the ſeamen, whereby they animated each other in their work of rowing. The word is formed from κελευειν, *to call, to give the ſignal.*

Celeusma, was alſo a kind of ſong or formula, rehearſed or played by the maſter, or others, to direct the ſtrokes and movements of the mariners, as well as to encourage them to labour. See Celeustes.

CELEUSTES, in *Ancient Navigation*, the boatſwain or officer appointed to give the rowers the ſignal, when they were to pull, and when to ſtop. He is alſo denominated *epopeus*, and by the Romans, *portiſculus;* ſometimes ſimply *hortator.*

CELIBACY, the ſtate of unmarried perſons. Scaliger derives the word from the Greek κοιτη, "bed," and λειπω, *linquo*, "I leave:" others ſay it is formed from *cæli beatitudo*, q. d. *the bleſſedneſs of heaven.*

The ancient Romans uſed all means imaginable to diſcourage celibacy. Nothing was more uſual than for the cenſors to impoſe a fine on bachelors. Dionyſius Halicarnaſſenſis mentions an ancient conſtitution whereby all perſons of full age were obliged to marry. But the firſt law of that kind, of which we have any certainty, is that under Auguſtus, called *lex Julia de maritandis ordinibus.* It was afterwards denominated *Papia Poppæa*, and more uſually *Julia Papia*, in regard of ſome new ſanction and amendments made to it under the conſuls Papius and Poppæus. By this law, divers prerogatives were given to perſons who had many children; penalties impoſed on thoſe who lived a ſingle life, as that they ſhould be incapable of receiving legacies, and not exceeding a certain proportion.

CELIBATE, the ſame with celibacy; but it is chiefly uſed in ſpeaking of the ſingle life of the Popiſh clergy, or the obligation they are under to abſtain from marriage. In this ſenſe we ſay the law of *celibate.* Monks and religious take a vow of celibate; and what is more, of chaſtity.

The church of Rome impoſes an univerſal celibacy on all its clergy, from the pope to the loweſt deacon and ſubdeacon. The advocates for this uſage pretend that a vow of perpetual celibacy was required in the ancient church as a condition of ordination, even from the earlieſt apoſtolic ages. But the contrary is evident from numerous examples of biſhops and archbiſhops, who lived in a ſtate of matrimony, without any prejudice to their ordination or their function. It is generally agreed that moſt of the apoſtles were married. Some ſay all of them, except St Paul and St John. Others ſay St Paul himſelf was married, becauſe he writes to his *yoke-fellow*, whom they interpret his wife. Be this as it will, in the next ages after the apoſtles, we have accounts of divers married biſhops, preſbyters, and deacons, without any reproof or mark of diſhonour ſet on them; *e. g.* Valens, preſbyter of Philippi, mentioned by Polycarp; and Chæremon, biſhop of Nilus. Novatus was a married preſbyter of Carthage, as we learn from Cyprian; who himſelf was alſo a married man, as Pagi confeſſes; and ſo was Cæcilius the preſbyter who converted him; and Numidius, another preſbyter of Carthage. The reply which the Romaniſts give to this is, that all married perſons, when they came to be ordained, promiſed to live ſeparate from their wives by conſent, which anſwered the vow of celibacy in other perſons. But this is not only ſaid without proof, but againſt it. For Novatus preſbyter of Carthage was certainly allowed to cohabit with his wife after ordination; as appears from the charge that Cyprian brings againſt him, that he had ſtruck and abuſed his wife, and thereby cauſed her to miſcarry. There ſeems indeed to have been, in ſome caſes, a tendency towards the introduction of ſuch a law by one or two zealots; but the motion was no ſooner made than it was quaſhed by the authority of wiſer men. Thus Euſebius obſerves, that Pinytus, biſhop of Gnoſſus in Crete, was for laying the law of celibacy upon his brethren; but Dionyſius biſhop of Corinth wrote to him, that he ſhould conſider the weakneſs of men, and not impoſe that heavy burden on them. In the council of Nice, anno 325, the motion was renewed for a law to oblige the clergy to abſtain from all conjugal ſociety with their wives, whom they had married before their ordination; but Paphnutius, a famous Egyptian biſhop, and one who himſelf never was married, vigorouſly declaimed againſt it, upon which it was unanimouſly rejected. So Socrates and Sozomen tell the ſtory; to which all that Valeſius, after Bellarmin, has to ſay, is, that he ſuſpects the truth of it. The council in Trullo, held in 692, made a difference in this reſpect between biſhops and preſbyters; allowing preſbyters, deacons, and all the inferior orders, to cohabit with their wives after ordination; and giving the Roman church a ſmart rebuke for the contrary prohibition, but at the ſame time laying an injunction upon biſhops to live ſeparate from their wives, and appointing the wives to betake themſelves to a monaſtic life, or become deaconeſſes in the church. And thus was a total celibate eſtabliſhed in the Greek church as to biſhops, but not any others. In the Latin church, the like eſtabliſhment was alſo made, but by ſlow ſteps in many places. For in Africa, even biſhops themſelves cohabited with their wives at the time of the council of Trullo. The celibacy of the clergy, however, appears of an ancient ſtanding, if not of command and neceſſity, yet as of counſel and choice. But as it is clearly neither of divine nor apoſtolical inſtitution, it is at firſt hard to conceive from what motive the court of Rome perſiſted ſo very obſtinately to impoſe this inſtitution on the clergy. But we are to obſerve that this was a leading ſtep to the execution of the project formed of making the clergy independent of princes, and rendering them a ſeparate body to be governed by their own laws. In effect, while prieſts had children, it was very difficult to prevent their dependence on princes, whoſe favours have ſuch an influence on private men; but having no family, they were more at liberty to adhere to the pope.

CELIDOGRAPHIA, the deſcription of the ſpots which appear on the ſurfaces of the ſun and planets. See ASTRONOMY.

CELL, *(Cella)* in ancient writers, denotes a place or apartment uſually under ground, and vaulted, in which were ſtored up ſome ſort of neceſſaries, as wine, honey, and the like; and according to which it was called *Cella Vinaria*, *Ollearia*, *Mellaria*, &c. The word is formed from the Latin *celare*, to conceal.

CELLA was alſo uſed for the lodge or habitation of a common proſtitute, as being anciently under ground, hence alſo denominated *fornix*.

> *Intravit calidum veteri centone lupanar,*
> *Et cellam vacuam.* Juv. Sat. vi. ver. 121.

On which place an ancient ſcholiaſt remarks, that the names of the whores were written on the doors of their ſeveral cells; by which we learn the meaning of *inſcripta cella* in Martial, lib. xi. Ep. 46.

CELLA was alſo applied to the bedchambers of domeſtics and ſervants; probably as being low and narrow.—Cicero, inveighing againſt the luxury of Antony, ſays the beds in the very cellæ of his ſervants were ſpread with pompous purple coverlets.

CELLA is alſo applied to the members or apartments of baths. Of theſe there were three principal, called *frigidaria*, *tepidaria*, and *caldaria*; to which may be added a fourth, called *cella aſſa*, and ſometimes *ſudatoria*.

CELLA likewiſe ſignified the *adyta*, or inmoſt and moſt retired parts of temples, wherein the images of the gods to whom the edifices were conſecrated were preſerved. In this ſenſe we meet with *cella Jovis*, *cella Concordiæ*.

CELLA is alſo uſed for a leſſer or ſubordinate ſort of monaſtery dependent on a great one, by which it was erected, and continues ſtill to be governed. The great abbeys in England had moſt of them *cells* in places diſtant from the mother abbey, to which they were accountable, and from which they received their ſuperiors. The alien priories in England were cells to abbeys in Normandy, France, Italy, &c. The name *cell* was alſo given to rich and conſiderable monaſteries not dependent on any other.

CELL ſignifies alſo a little apartment or chamber, ſuch as thoſe wherein the ancient monks, ſolitaries, and hermits, lived in retirement. Some derive the word from the Hebrew כלא, *i. e.* "a priſon, or place where any thing is ſhut up."

The ſame name is ſtill retained in divers monaſteries. The dormitory is frequently divided into ſo many cells or lodges. The Carthuſians have each a ſeparate houſe, which ſerves them as a cell. The hall wherein the Roman conclave is held, is divided by partitions into divers cells, for the ſeveral cardinals to lodge in.

CELL is alſo a name given to the little diviſions in honeycombs, which are always regular hexagons. See BEE.

CELL, in *Botany*, is applied to the hollow place between the partitions in the pods, huſks, and other ſeed-veſſels of plants: according as there is one, two, three, &c. of theſe cells, the veſſel is ſaid to be unilocular, bilocular, trilocular, &c.

CELLS, in *Anatomy*, little bags, or bladders, where fluids or other matters are lodged; called *loculi*, *cellulæ*, &c. Thus the *cellulæ adipoſæ* are the little cells where the fat is contained; *cellulæ* in the *colon*, are ſpaces wherein the excrements are detained till voided, &c.

CELLAR *(Cellarium)*, in ancient writers, denotes the ſame with cella, viz. a conſervatory of eatables, or drinkables.

Cellar differs from vault, as the latter is ſuppoſed to be deeper, the former being frequently little below the ſurface of the ground. In which ſenſe, *cellarium* alſo differed from *penus*, as the former was only a ſtorehouſe for ſeveral days, the latter for a long time. Thus it is the bactroperatæ, a ſort of ancient Cynics, are ſaid by St Jerome to carry their cellar about with them.

Cellarium alſo denoted an allowance of bread, wine, oil, or other proviſion, furniſhed out of the cella, to the uſe of the governor of the province and his officers, &c. In which ſenſe, the word amounts to much the ſame with *annona*.

CELLARS, in modern building, are the loweſt rooms in a houſe, the ceilings of which uſually lie level with the ſurface of the ground on which the houſe is built; or they are ſituated under the pavement before the houſe, eſpecially in ſtreets and ſquares.

Cellars, and other places vaulted under ground, were called by the Greeks *hypogæa*: the Italians ſtill call them *fundi delli caſe*.

CELLARER, or CELLERER, *(Cellerarius* or *Cellarius)*, an officer in monaſteries, to whom belong the care and procurement of proviſions for the convent. The denomination is ſaid to be borrowed from the Roman law, where *cellarius* denotes an examiner of accounts and expences. Ulpian defines it thus: "Cellerarius, id eſt, ideo præpoſitus ut rationes ſalvæ ſint."

The *cellerarius* was one of the four *obedientiarii*, or great officers of monaſteries: under his ordering was the *piſtrinum* or bakehouſe, and the *bracinum* or brewhouſe. In the richer houſes there were particular lands ſet apart for the maintenance of his office, called in ancient writings *ad cibum monachorum*. The *cellerarius* was a great man in the convent. His whole office in ancient times had a reſpect to that origin: he was to ſee his lord's corn got in, and laid up in granaries; and his appointment conſiſted in a certain proportion thereof, uſually fixed at a thirteenth part of the whole, together with a furred gown. The office of cellarer then only differed in name from thoſe of bailiff and minſtrel; excepting that the cellaler had the receipt of his lord's rents throughout the whole extent of his juriſdiction.

CELLARER was alſo an officer in chapters, to whom belonged the care of the temporals, and particularly the diſtributing of bread, wine, and money, to canons, on account of their attendance in the choir. In ſome places he was called *cellarer*, in others *burſer*, and in others *currier*.

CELLARIUS, CHRISTOPHER, was born in 1638, at Smalcade in Franconia, of which town his father was miniſter. He was ſucceſſively rector of the colleges at Weymar, Zeits, and Merſbourg: and the king of Pruſſia having founded an univerſity at Halle in 1693, he was prevailed on to be profeſſor of eloquence and hiſtory there, where he compoſed the greateſt part of his works. His great application to ſtudy haſtened the infirmities of old age; for it is ſaid, he would ſpend whole days and nights together at his books, without any attention to his health, or even the calls of nature. His works relate to grammar, geography, hiſtory, and the oriental languages: and the number of them is amazing. He died in 1707.

CELLINI, BENVENUTO, an eminent ſtatuary. who was bred a jeweller and goldſmith, but ſeems to have had an extraordinary genius for the fine arts in general. He was cotemporary with Michael Angelo and Julio Romano, and was employed by popes, kings, and other princely patrons of ſciences and arts, ſo highly cultivated in the days of Leo X. and Charles V. ſome of his productions being eſteemed moſt exquiſite. He lived to a very conſiderable old age; and his life, almoſt to the laſt, was a continued ſcene of adventure, perſecution, and misfortune, truly wonderful. He wrote his own hiſtory, which was not, however, publiſhed till the year 1730, probably on account of the exceſſive freedom with which he therein treated many diſtinguiſhed perſonages of Italy and other countries. It was tranſlated into Engliſh by Dr Nugent in 1771, to which the reader is referred, as it will not admit of an abridgement ſuitable to the deſign of this work.

CELLULAR, in a general ſenſe, is applied to any thing conſiſting of ſingle cells.

CELLULAR Membrane. See ANATOMY *Index*.

CELOSIA, COCKS-COMB. See BOTANY *Index*.

CELSIA. See BOTANY *Index*.

CELSUS, AURELIUS CORNELIUS, a celebrated phyſician of the firſt century, who wrote eight books on medicine, in elegant Latin. He was the Hippocrates of the Latins; and Quintilian gives him a high eulogium. The great Boerhaave tells us, that Celſus is one of the beſt authors of antiquity for letting us into the true meaning and opinions of Hippocrates; and that without him, the writings of this father in phyſic would be often unintelligible, often miſunderſtood by us. He ſhows us alſo how the ancients cured diſtempers by friction, bathing, &c. His eight books *de Medicina* have been ſeveral times printed. The Elzevir edition, in the year 1650, by Vander Linden, is the beſt, as being entirely corrected from his manuſcripts.

CELSUS, an Epicurean philoſopher, in the ſecond century. He wrote a work againſt the Chriſtians, entitled, *The True Diſcourſe*: to which Origen, at the deſire of Ambroſe his friend, wrote a learned anſwer. To this philoſopher Lucian dedicated his *Pſeudomanies*.

CELTÆ, or CELTES, an ancient nation, by which moſt of the countries of Europe are thought to have been peopled. The compilers of the Univerſal Hiſtory are of opinion that they were deſcended from Gomer the eldeſt ſon of Japhet, the ſon of Noah. They think that Gomer ſettled in the province of Phrygia in Aſia; Aſhkenaz his eldeſt ſon, or Togarmah his youngeſt, or both, in Armenia; and Riphath the ſecond ſon in Cappadocia. When they ſpread themſelves wider, they ſeem to have moved regularly in columns without interfering with or diſturbing their neighbours. The deſcendants of Gomer, or the Celtæ, took the left hand, inſenſibly ſpreading themſelves weſtward towards Poland, Hungary, Germany, France, and Spain; while the deſcendants of Magog, Gomer's brother, moving eaſtward, peopled Tartary.

In this large European tract, the Celtes began to appear a powerful nation under a regular monarchy, or rather under ſeveral conſiderable kingdoms Mention is made of them indeed in ſo many parts of Europe, by ancient geographers and hiſtorians, that Ortellius took *Celtica* to be a general name for the continent of Europe, and made a map of it bearing this title. In thoſe parts of Aſia which they poſſeſſed, as well as in the different parts of Europe, the Celtes went by various names. In Leſſer Aſia they were known by the names of *Titans* and *Sacks*; in the northern parts of Europe, by thoſe of *Cymmerians*, *Cymbrians*, &c.; and in the ſouthern parts they were called *Celtes*, *Gauls*, or *Galatians*.

With reſpect to the government of the Celtes we are entirely in the dark. All we know is, that the curates, and afterwards druids and bards, were the interpreters of their laws; judged all cauſes whether criminal or civil; and their ſentence was reckoned ſo ſacred, that whoever refuſed to abide by it was by them excluded from aſſiſting at their ſacred rites; after which no man dared to converſe with him: ſo that this puniſhment was reckoned the moſt ſevere of all, even ſeverer than death itſelf.

They neither reared temples nor ſtatues to the Deity, but deſtroyed them wherever they could find them, planting in their ſtead large ſpacious groves; which, being open on the top and ſides, were, in their opinion, more acceptable to the divine Being, who is abſolutely unconfined. In this their religion ſeems to have reſembled that of the Perſees and diſciples of Zoroaſter. The Celtes only differed from them in making the oak inſtead of fire the emblem of the Deity; in chooſing that tree above all others to plant their groves with, and attributing ſeveral ſupernatural virtues both to its wood, leaves, fruit, and miſletoe; all of which were made uſe of in their ſacrifices and other parts of their worſhip. But after they had adopted the idolatrous ſuperſtition of the Romans and other nations, and the apotheoſis of their heroes and princes, they came to worſhip them much in the ſame manner; as Jupiter under the name of *Taran*, which in the Celtic ſignifies thunder; Mercury, whom ſome authors call *Heu* or *Heſus*, probably from the Celtic *haudh*, which ſignifies a dog, and might be the *Anubis* *latrans* of the Egyptians. But Mars was held in the greateſt veneration by the warlike, and Mercury by the trading, part of the nation. The care of religion was immediately under the curates, ſince known by the name of druids and bards. Theſe were, as Cæſar tells us, the performers of ſacrifices and all religious rites, and expounders of religion to the people. They alſo inſtructed youth in all kinds of learning, ſuch as philoſophy, aſtronomy, aſtrology, &c. Their doctrines were taught only by word of mouth, eſteeming them too ſacred to be committed to writing.—Other more common ſubjects, ſuch as their hymns to their gods, the exploits of princes and generals in time of war, and eſpecially before a battle, were couched in elegant verſe, and recited, or rather ſung, on all proper occaſions; though even theſe were alſo kept from vulgar eyes, and either committed to memory, or, if to writing, the whole was a ſecret to all the laity. The latter indeed ſeems the moſt probable, if what Cæſar hints be true; namely, that thoſe poetic records were increaſed in his time to ſuch a bulk, that it took up a young bard near 20 years to learn them by heart. Diodorus tells us farther, that theſe poets uſed to accompany their ſongs with inſtrumental muſic, ſuch as thoſe of organs, harps, and the like; and that they were held in ſuch veneration, that if in the time of an engagement between two armies, one of theſe bards appeared, both ſides immediately ceaſed fighting. The reaſon of this was, that they were univerſally believed to be prophets as well as poets; ſo that it was thought dangerous as well as injurious to diſobey what they ſuppoſed came from their gods. Theſe prophetic philoſophers kept academies, which were reſorted to, not only by a great number of their own youth, but alſo of thoſe from other countries, inſomuch that Ariſtotle ſays, their philoſophy paſſed from thence into Greece, and not from Greece thither. Diodorus likewiſe quotes a paſſage from Hecateus, which is greatly in their praiſe; viz. that the druids had ſome kinds of inſtruments by which they could draw diſtant objects nearer, and make them appear larger and plainer; and by which they could diſcover even ſeas, mountains, and valleys, in the moon. But whatever might be their learning, it is certain, that in proceſs of time they adopted ſeveral very barbarous cuſtoms, ſuch as ſacrificing human victims to their gods, as more acceptable to them than thoſe of any other animals. And Diodorus tells us of another inhuman cuſtom they uſed in their divinations, eſpecially in great matters, which was done by killing ſome of their ſlaves, or ſome priſoners of war, if any they had, with a ſcimitar, to draw the augury from the running of his blood from his mangled limbs.

For the hiſtory, &c. of the different Celtic nations ſee the article GAUL, &c.

CELTES, certain ancient inſtruments of a wedge-like form, of which ſeveral have been diſcovered in different parts of Great Britain. Antiquarians have generally attributed them to the Celtæ; but not agreeing as to their uſe, diſtinguiſhed them by the above unmeaning appellation. But Mr Whitaker makes it probable that they were Britiſh battle axes. See *BATTLE-Axe*.

CELTIBERIA, in *Ancient Geography*, a country of the Hither Spain, along the right or ſouth-weſt ſide of the river Iberus; though ſometimes the greateſt part of Spain was called by the name *Celtiberia*. The people were denominated *Celtiberi*, or the Celtæ ſeated on the Iberus. They were very brave and warlike; their cavalry in particular was excellent. They wore a black and rough cloak, the ſhag of which was like goats hair. Some of them had light bucklers like the Gauls: others hollow and round ones like thoſe of other nations. They all wore boots made of hair, and iron helmets adorned with creſts of a purple colour. They uſed ſwords which cut on both ſides, and poniards of a foot long. Their arms were of an admirable temper, and are ſaid to have been prepared in the following manner: they buried plates of iron under ground, where they let them remain till the ruſt had eaten the weakeſt part of the metal, and the reſt was conſequently hard and firm. Of this excellent iron they made their ſwords, which were ſo ſtrong and well tempered, that there was neither buckler nor helmet that could reſiſt their edge. The Celtiberians were very cruel towards their enemies and malefactors, but ſhowed the greateſt humanity to their gueſts. They not only cheerfully granted their hoſpitality to ſtrangers, who travelled in their country, but were deſirous that they ſhould ſeek protection under their roof.

CELTIS. See BOTANY *Index*.

CEMENT, in a general ſenſe, any glutinous ſubſtance capable of uniting and keeping things together in cloſe coheſion. In this ſenſe the word *cement* comprehends mortar, ſoder, glue, &c. but has been generally reſtrained to the compoſitions uſed for holding together broken glaſſes, china, and earthen ware. For this purpoſe the juice of garlic is recommended as exceedingly proper, being both very ſtrong, and, if the operation is performed with care, leaving little or no mark. Quicklime and the white of an egg mixed together and expeditiouſly uſed, are alſo very proper for this purpoſe. Dr Lewis recommends a mixture of quicklime and cheeſe in the following manner: "Sweet cheeſe ſhaved thin, and ſtirred with boiling-hot-water, changes into a tenacious ſlime which does not mingle with the water. Worked with freſh particles of hot water, and then mixed upon a hot ſtone with a proper quantity of unſlacked lime, to the conſiſtence of a paſte, it proves a ſtrong and durable cement for wood, ſtone, earthen ware, and glaſs. When thoroughly dry, which will be in two or three days, it is not in the leaſt acted upon by water. Cheeſe barely beat with quicklime, as directed by ſome of the chemiſts for luting cracked glaſſes, is not near ſo efficacious." A compoſition of the drying oil of linſeed and white lead is alſo uſed for the ſame purpoſes, but is greatly inferior.

CEMENT, in building, is uſed to denote any kind of mortar of a ſtronger kind than ordinary. The cement commonly uſed is of two kinds; hot and cold. The hot cement is made of roſin, bees-wax, brick-duſt, and chalk boiled together. The bricks to be cemented are heated, and rubbed one upon another, with cement between them. The cold cement is that above deſcribed for cementing china, &c. which is ſometimes, though rarely, employed in building.

The ruins of the ancient Roman buildings are found to cohere ſo ſtrongly, that moſt people have imagined the ancients were acquainted with ſome kind of mortar, which, in compariſon of ours, might juſtly be called *cement*; and that to our want of knowledge of the materials they uſed, is owing the great inferiority of modern buildings in their durability. In 1770, one M. Loriot, a Frenchman, pretended to have diſcovered the ſecret of the ancient cement, which, according to him, was no more than a mixture of powdered *quicklime* with lime which had been long ſlacked and kept under water. The ſlacked lime was firſt to be made up with ſand, earth, brickduſt, &c. into mortar after the common method, and then about a third part of quicklime in powder was added to the mixture. This produced an almoſt inſtantaneous petrification, ſomething like what is called the *ſetting* of alabaſter, but in a much ſtronger degree; and was poſſeſſed of many wonderful qualities needleſs here to relate, ſeeing it has never been known to ſucceed with any other perſon who tried it. Mr Anderſon, in his eſſays on agriculture, has diſcuſſed this ſubject at conſiderable length, and ſeemingly with great judgment. He is the only perſon we know who has given any rational theory of the uſes of lime in building, and why it comes to be the proper baſis of all cements. His account is in ſubſtance as follows:

Lime which has been ſlacked and mixed with ſand, becomes hard and conſiſtent when dry, by a proceſs ſimilar to that which produces the natural *ſtalactites* in caverns. Theſe are always formed by water dropping from the roof. By ſome unknown and inexplicable proceſs of nature, this water has diſſolved in it a ſmall portion of calcareous matter in a *cauſtic* ſtate. As long as the water continues covered from the air, it keeps the earth diſſolved in it; it being the natural property of calcareous earths, when deprived of their fixed air, to diſſolve in water. But when the ſmall drop of water comes to be expoſed to the air, the calcareous matter contained in it begins to attract the fixable part of the atmoſphere. In proportion as it does ſo, it alſo begins to ſeparate from the water, and to reaſſume its native form of limeſtone or marble. This proceſs Mr Anderſon calls a *cryſtallization*; and when the calcareous matter is perfectly *cryſtallized* in this manner, he affirms, that it is to all intents and purpoſes limeſtone or marble of the ſame conſiſtence as before: and "in this manner (ſays he), within the memory of man, have hudge rocks of marble been formed near Matlock in Derbyſhire." If lime in a cauſtic ſtate is mixed with water, part of the lime will be diſſolved, and will alſo begin to cryſtallize. The water which parted with the cryſtallized lime will then begin to act upon the remainder, which it could not diſſolve before; and thus the proceſs will continue, either till the lime be all reduced to an *effete*, or (as he calls it) *cryſtalline* ſtate, or ſomething hinders the action of the water upon it. It is this cryſtallization which is obſerved by the workmen when a heap of lime is mixed with water, and left for ſome time to macerate. A hard cruſt is formed upon the ſurface, which is ignorantly called *froſting*, though it takes place in ſummer as well as in winter. If therefore the hardneſs of the lime, or its becoming a cement, depends entirely on the formation of its cryſtals, it is evident that the perfection of the cement muſt depend on the perfection of the cryſtals, and the hardneſs of the matters which are entangled among them. The additional ſubſtances uſed in making of mortar, ſuch as ſand, brickduſt, or the like, according to Mr Anderſon, ſerve only for a purpoſe ſimilar to what is anſwered by ſticks put into a veſſel full of any ſaline ſolution, namely, to afford the cryſtals an opportunity of faſtening themſelves upon it. If therefore the matter interpoſed between the cryſtals of the lime is of a friable, brittle nature, ſuch as brickduſt or chalk, the mortar will be of a weak and imperfect kind; but, when the particles are hard, angular, and very difficult to be broken, ſuch as thoſe of river or pit ſand, the mortar turns out exceedingly good and ſtrong. Sea ſand is found to be an improper material for mortar, which Mr Anderſon aſcribes to its being leſs angular than the other kinds. That the cryſtallization may be the more perfect, he alſo recommends a large quantity of water, that the ingredients be perfectly mixed together, and that the drying be as ſlow as poſſible. An attention to theſe circumſtances, he thinks, would make the buildings of the moderns equally durable with thoſe of the ancients; and from what remains of the ancient Roman works, he thinks a very ſtrong proof of his hypotheſis might be adduced. The great thickneſs of their walls neceſſarily required a vaſt length of time to dry. The middle of them was compoſed of pebbles thrown in at random, and which have evidently had mortar ſo thin as to be *poured* in among them. By this means a great quantity of the lime would be diſſolved, and the cryſtallization performed in the moſt perfect manner; and the indefatigable pains and perſeverance for which the Romans were ſo remarkable in all their undertakings, leave no room to doubt that they would take care to have the ingredients mixed together as well as poſſible. The conſequence of all this is, that the buildings formed in this manner are all as firm as if cut out of a ſolid rock; the mortar being equally hard, if not more ſo, than the ſtones themſelves.

Notwithſtanding the bad ſucceſs of thoſe who have attempted to repeat M. Loriot's experiments, however, Dr Black informs us, that a cement of this kind is certainly practicable. It is done, he ſays, by powdering the lime while hot from the kiln, and throwing it into a thin paſte of ſand and water; which, not ſlacking immediately, abſorbs the water from the mortar by degrees, and forms a very hard maſs. "It is plain, he adds, that the ſtrength of this mortar depends on uſing the lime hot or freſh from the kiln."

By mixing together gypſum and quicklime, and then adding water, we may form a cement of tolerable hardneſs, and which apparently might be uſed to advantage in making troughs for holding water, or lining ſmall canals for it to run in. Mr Wiegley ſays, that a good mortar or cement, which will not crack, may be obtained by mixing three parts of a thin magma of ſlacked lime with one of powdered gypſum; but adds, that it is uſed only in a dry ſituation. A mixture of tarras with ſlacking lime acquires in time a ſtony hardneſs, and may be uſed for preventing water from entering. See MORTAR and STUCCO.

CEMENT, among engravers, jewellers, &c. is the ſame with the hot cement uſed in building*; and is uſed for keeping the metals to be engraven firm to the block, and alſo for filling up what is to be chiſſeled.

* See the foregoing article.

CEMENT, in *Chemiſtry*, is uſed to ſignify all thoſe powders and paſtes with which any body is ſurrounded in pots or crucibles, and which are capable by the help of fire of producing changes upon that body. They are made of various materials; and are uſed for different purpoſes, as for parting gold from ſilver, converting it into ſteel, copper into braſs: and by cementation more conſiderable changes can be effected upon bodies, than by applying to them liquids of any kind; becauſe the active matters are then in a ſtate of vapour, and aſſiſted by a very conſiderable degree of heat.

Cement which quickly hardens in water. This is deſcribed in the poſthumous works of Mr Hooke, and is recommended for gilding live craw fiſh, carps, &c. without injuring the fiſh. The cement for this purpoſe is prepared, by putting ſome Burgundy pitch into a new earthen pot, and warming the veſſel till it receives ſo much of the pitch as will ſtick round it, then ſtrewing ſome finely-powdered amber over the pitch when growing cold, adding a mixture of three pounds of linſeed oil, and one of oil of turpentine, covering the veſſel and boiling them for an hour over a gentle fire, and grinding the mixture as it is wanted with as much pumice-ſtone in fine powder as will reduce it to the conſiſtence of paint. The fiſh being wiped dry, the mixture is ſpread upon it; and the gold leaf being then laid on, the fiſh may be immediately put into water again, without any danger of the gold coming off, for the matter quickly grows hard in the water.

Cement Pot, are theſe earthen pots uſed in the cementation of metals.

CEMENTATION, the act of corroding or otherwiſe changing a metal by means of a Cement.

CEMETERY (κοιματηριον, from κοιμαω, to "*ſleep;*") a place ſet apart or conſecrated for the burial of the dead.

Anciently none were buried in churches or church-yards: it was even unlawful to inter in cities, and the cemeteries were without the walls. Among the primitive Chriſtians theſe were held in great veneration. It even appears from Euſebius and Tertullian, that, in the early ages, they aſſembled for divine worſhip in the cemeteries. Valerian ſeems to have confiſcated the cemeteries and other places of divine worſhip, but they were reſtored again by Gallienus. As the martyrs were buried in theſe places, the Chriſtians choſe them for building churches on, when Conſtantine eſtabliſhed their religion; and hence ſome derive the rule which ſtill obtains in the church of Rome, never to conſecrate an altar without putting under it the relicks of ſome ſaint. The practice of conſecrating cemeteries is of ſome antiquity. The biſhop walked round it in proceſſion, with the croſier or paſtoral ſtaff in his hand, the holy water pot being carried before, out of which the aſperſions were made.

CENCHRUS. See Botany *Index*.

CENEGILD, in the Saxon antiquities, an expiatory mulct, paid by one who had killed a man to the kindred of the deceaſed. The word is compounded of the Saxon *cinne*, i. e. *cognatio*, "relation," and *gild*, *ſolutio*, "payment."

CENOBITE. See Coenobite.

CENOTAPH, in antiquity, an empty tomb, erected by way of honour to the deceaſed. It is diſtinguiſhed from a ſepulchre, in which a coffin was depoſited. Of theſe there were two ſorts; one for thoſe who had, and another for thoſe who had not, been honoured with funeral rites in another place.

The ſign whereby honorary ſepulchres were diſtinguiſhed from others, was commonly the wreck of a ſhip, to denote the deceaſe of the perſon in ſome foreign country.

CENSER, in antiquity, a vaſe containing incenſe to be uſed in ſacrifices. Cenſer is chiefly uſed in ſpeaking of the Jewiſh worſhip. Among the Greeks and Romans it is more frequently called *thuribulum*, λιβανωτις, and *acerra*.

The Jewiſh cenſer was a ſmall ſort of chafing diſh, covered with a dome, and ſuſpended by a chain. Joſephus tells us, that Solomon made 20,000 gold cenſers for the temple of Jeruſalem, to offer perfumes in, and 50,000 others to carry fire in.

CENSIO, in antiquity, the act or office of the cenſor. See Census.

Cenſio included both the rating or valuing a man's eſtate, and the impoſing mulcts and penalties.

Censio haſtaria, a puniſhment inflicted on a Roman ſoldier for ſome offence, as lazineſs or luxury, whereby his *haſta* or ſpear was taken from him, and conſequently his wages and hopes of preferment ſtopped.

CENSITUS, a perſon cenſed, or entered in the cenſual tables. See Census.

In an ancient monument found at Ancyra containing the actions of the emperor Octavius, we read,

Quo luſtro civium Romanorum
Cenſita ſunt capita quadragies
Centum millia et ſexaginta tria.

Censitus is alſo uſed in the civil law for a ſervile ſort of tenant, who pays capitation to his lord for the lands he holds of him, and is entered as ſuch in the lord's rent roll. In which ſenſe, the word amounts to the ſame with *capite cenſus*, or *capite cenſitus*. See *Capite Cenſi.*

CENSOR, (from *cenſere* to "think" or "judge,") one of the prime magiſtrates in ancient Rome. Their buſineſs was to regiſter the effects of the Roman citizens, to impoſe taxes in proportion to what each man poſſeſſed, and to take cognizance or inſpection of the manners of the citizens. In conſequence of this laſt part of their office, they had a power to cenſure vice or immorality, by inflicting ſome public mark of ignominy on the offender. They had even a power to create the *princeps ſenatus*, and to expel from the ſenate ſuch as they deemed unworthy of that office. This power they ſometimes exerciſed without ſufficient grounds; and therefore a law was at length paſſed, that no ſenator ſhould be degraded or diſgraced in any manner, until he had been formally accuſed and found guilty by both the cenſors. It was alſo a part of the cenſorian juriſdiction, to fill up the vacancies in the ſenate, upon any remarkable deficiency in their number; to let out to farm all the lands, revenues, and cuſtoms, of the republic; and to contract with artificers for the charge of building and repairing all the public works and edifices both in Rome and the colonies of Italy. In all parts of their office, however, they were ſubject to the juriſdiction of the people; and an appeal always lay from the ſentence of the cenſors to that of an aſſembly of the people.

The firſt two cenſors were created in the year of Rome 311, upon the ſenate's obſerving that the conſuls were ſo much taken up with war as not to have time to look into other matters. The office continued to the time of the emperors, who aſſumed the cenſorial power, calling themſelves *morum præfecti*; though Veſpaſian and his ſons took the title of cenſors. Decius attempted to reſtore the dignity to a particular magiſtrate. After this we hear no more of it, till Conſtantine's time, who made his brother cenſor, and he ſeems to have been the laſt that enjoyed the office.

The office of cenſor was ſo conſiderable, that for a long time none aſpired to it till they had paſſed all the reſt; ſo that it was thought ſurpriſing that Craſſus ſhould be admitted cenſor, without having been either conſul or prætor. At firſt the cenſors enjoyed their dignity for five years, but in 420 the dictator Mamercus made a law reſtraining it to a year and a half, which was afterwards obſerved very ſtrictly. At firſt one of the cenſors was elected out of a patrician, and the other out of a plebeian family; and upon the death of either, the other was diſcharged from his office, and two new ones elected, but not till the next luſtrum. In the year of Rome 622, both cenſors were choſen from among the plebeians; and after that time the office was ſhared between the ſenate and people. After their election in the Comitia Centuriata, the cenſors proceeded to the capitol, where they took an oath not to manage either by favour or diſaffection, but to act equitably and impartially throughout the whole courſe of their adminiſtration.

The republic of Venice ſtill has a cenſor of the manners of their people, whoſe office laſts ſix months.

Censors of Books, are a body of doctors or others eſtabliſhed in divers countries to examine all books before they go to the preſs, and to ſee they contain nothing contrary to faith and good manners.

At Paris, before the late revolution, the faculty of theology claimed this privilege as granted to them by the pope; but, in 1624, new commiſſions of four doctors were created, by letters patent, the ſole cenſors of all books, and anſwerable for every thing contained therein.

In England, we had formerly an officer of this kind, under the title of licenſer of the preſs: but, ſince the Revolution, our preſs has been laid under no ſuch reſtraint.

CENSORINUS, a celebrated writer in the third century, well known by his treatiſe *De die Natali*. This treatiſe, which was written about the year 238, Gerard Voſſius calls a little book of gold; and declares it to be a moſt learned work, of the higheſt uſe and importance to chronologers, ſince it connects and determines, with great exactneſs, ſome of the principal eras in pagan hiſtory. It was printed at Cambridge, with the notes of Lindenbrokius, in 1695.

CENSURE, a judgment which condemns ſome book, perſon, or action, or more particularly, a reprimand from a ſuperior. Eccleſiaſtical cenſures are penalties, by which, for ſome remarkable miſbehaviour, Chriſtians are deprived of the communion of the church, or prohibited to exerciſe the ſacerdotal office.

CENSUS, in Roman antiquity, an authentic declaration made before the cenſors, by the ſeveral ſubjects of the empire, of their reſpective names and places of abode. This declaration was regiſtered by the cenſors; and contained an enumeration, in writing, of all the eſtates, lands, and inheritances they poſſeſſed; their quantity, quality, place, wives, children, domeſtics, tenants, ſlaves. In the provinces the cenſus ſerved not only to diſcover the ſubſtance of each perſon, but where, and in what manner and proportion, taxes might be beſt impoſed. The cenſus at Rome is commonly thought to have been held every five years; but Dr Middleton hath ſhown, that both cenſus and luſtrum were held irregularly and uncertainly at various intervals. The cenſus was an excellent expedient for diſcovering the ſtrength of the ſtate; for by it they diſcovered the number of the citizens, how many were fit for war, and how many for offices of other kinds; how much each was able to pay of taxes, &c. It went through all ranks of people, though under different names: that of the common people was called *cenſus*; that of the knights, *cenſus*, *recenſio*, *recognitio*; that of the ſenators, *lectio*, *relectio*.—Hence alſo *cenſus* came to ſignify a perſon who had made ſuch a declaration; in which ſenſe it was oppoſed to *incenſus*, a perſon who had not given in his eſtate or name to be regiſtered.

The cenſus, according to Salmaſius, was peculiar to the city of Rome. That in the provinces was properly called *profeſſio* and απογραφη. But this diſtinction is not everywhere obſerved by the ancients themſelves.

Census was alſo uſed for the book or regiſter wherein the profeſſions of the people were entered: In which ſenſe, the cenſus was frequently cited and appealed to as evidence in the courts of juſtice.

Census is alſo uſed to denote a man's whole ſubſtance or eſtate.

Census Senatorius, the patrimony of a ſenator, which was limited to a certain value; being at firſt rated at 800,000 ſeſterces, but afterwards, under Auguſtus, enlarged to 1,200,000.

Census Equeſter, the eſtate or patrimony of a knight, rated at 400,000 ſeſterces, which was required to qualify a perſon for that order, and without which no virtue or merit was available.

Census was alſo uſed for a perſon worth 100,000 ſeſterces, or who was entered as ſuch in the cenſual tables, on his own declaration. In which ſenſe, cenſus amounts to the ſame with *claſſicus*, or a man of the firſt claſs; though Gellius limits the eſtate of thoſe of this claſs to 125,000 aſſes. By the Voconian law, no cenſus was allowed to give by his will above a fourth part of what he was worth to a woman.

Census was alſo uſed to denote a tax or tribute impoſed on perſons, and called alſo capitation. See *Capite Cenſi*.

Census Dominicatus, in writers of the lower age, denotes a rent due to the lord.

Census Duplicatus, a double rent or tax, paid by vaſſals to their lord on extraordinary or urgent occaſions; as expeditions to the Holy Land, &c.

Census Eccleſiæ Romanæ, was an annual contribution voluntarily paid to the ſee of Rome by the ſeveral princes of Europe.

CENT, ſignifies properly a hundred, being an abridgement of the word *centum;* but is often uſed in commerce to expreſs the profit or loſs ariſing from the ſale of any commodity: ſo that when we ſay there is 10 *per cent.* profit, or 10 *per cent* loſs, upon any merchandiſe that has been ſold, it is to be underſtood that the ſeller has either gained or loſt 10l. on every 100l. of the price at which he bought that merchandiſe; which is $\frac{1}{10}$ of profit, or $\frac{1}{10}$ of loſs, upon the total of the ſale.

CENTAUR, in *Aſtronomy*, a part or moiety of a ſouthern conſtellation, in form half man half horſe; uſually joined with the wolf. The word comes from κενταυρος, formed of κεντειν, *pungo;* and ταυρος, *bull;* q. d. *bull pricker*. The ſtars of this conſtellation, in Ptolemy's Catalogue, are 37; in Tycho's 4; and in the Britannic Catalogue, with Sharp's Appendix, 35.

CENTAURS, in *Mythology*, a kind of fabulous monſters, half men and half horſes.—The poets pretend that the centaurs were the ſons of Ixion and a cloud; the reaſon of which fancy is, that they retired to a caſtle called νεφελη, which ſignifies "a cloud."—This fable is differently interpreted: ſome will have the centaurs to have been a body of ſhepherds and herdſmen, rich in cattle, who inhabited the mountains of Arcadia, and to whom is attributed the invention of bucolic poetry. Palæphætus, in his book of incredibles, relates, that under the reign of Ixion, king of Theſſaly, a herd of bulls on Mount Theſſaly run mad, and ravaged the whole country, rendering the mountains inacceſſible; that ſome young men who had found the art of taming and mounting horſes, undertook to clear the mountains of theſe animals, which they purſued on horſeback, and thence obtained the appellation of *Centaurs*. This ſucceſs rendering them inſolent, they inſulted the Lapithæ, a people of Theſſaly: and becauſe when attacked they fled with great rapidity, it was ſuppoſed they were half horſes and half men.—The Centaurs in reality were a tribe of Lapithæ, who inhabited the city Pelethronium adjoining to Mount Pelion, and firſt invented the art of breaking horſes, as is intimated by Virgil.

CENTAUREA, GREATER CENTAURY. See BOTANY *Index*. There are 61 ſpecies belonging to this genus. The root of one of them called *glaſtifolia*, is an article in the materia medica. It has a rough, ſomewhat acrid taſte, and abounds with a red viſcid juice. Its rough ſtate has gained it ſome eſteem as an aſtringent, its acrimony as an aperient, and its glutinous quality as a vulnerary: but the preſent practice takes very little notice of it in any intention. Another of the ſpecies is the cyanus or blue bottle, which grows commonly among corn. The expreſſed juice of this flower ſtains linen of a beautiful blue colour, but is not permanent. Mr Boyle ſays, that the juice of the inner petals, with a little alum, makes a beautiful permanent colour, equal to ultramarine.

Leſſer CENTAURY. See GENTIANA, BOTANY *Index*.

CENTELLA. See BOTANY *Index*.

CENTENARIUS, or CENTENARIO, in the middle age, an officer who had the government or command, with the adminiſtration of juſtice, in a village. The centenarii as well as vicarii were under the juriſdiction and command of the court. We find them among the Franks, Germans, Lombards, Goths, &c.

CENTENARIUS was alſo uſed for an officer who had the command of 100 men, moſt frequently called a CENTURION.

CENTENARIUS, in monaſteries, was an officer who had the command of 100 monks.

CENTENINUM OVUM, among naturaliſts, denotes a ſort of hen's egg much ſmaller than ordinary, vulgarly called a *cock's egg;* from which it has been fabulouſly held that the cockatrice or baſiliſk is produced. The name is taken from an opinion, that theſe are the laſt eggs which hens lay, having laid 100 before; whence *centeninum*, q. d. the hundredth egg.—Theſe eggs have no yolks, but in other reſpects differ not from common ones, having the albumen, chalazes, membranes, &c. in common with others. In the place of the yolk is found a little body like a ſerpent coiled up, which doubtleſs gave riſe to the fable of the baſiliſk's origin from thence. Their origin is with probability aſcribed by Harvey to this, that the yolks in the vitellary of the hen are exhauſted before the albumina.

CENTER, or CENTRE, in a general ſenſe, ſignifies a point equally diſtant from the extremities of a line, figure, or body. The word is formed from the Greek κεντρον, a *point*.

CENTRE of an Arch. Under the article BRIDGE, the different forms of arches have been particularly conſidered.

Under this article, it comes very properly to be aſcertained in what manner the arch-ſtones are ſupported till the arch is completed, and the moſt commodious and leaſt expenſive manner in which this can be accompliſhed. When the ſpan is ſmall, and upon a limited ſcale, as cellars, and vaults below ground, the foundation of the ſide-walls is dug out, the earth rounded off betwixt, the arch thrown over upon it, and the earth is afterwards dug out and carried away. This muſt have been done on any account. By this method the wood and workmanſhip are ſaved; but it is only in particular inſtances that this can be done. When the arch to be caſt is on land, and at no great height above the ſurface of the earth, a frame for ſupporting the arch-ſtones can be raiſed from the earth, and bound together, frequently, with a great profuſion of wood, which on account of the ſmallneſs of the arch is not taken into account; but, when the ſpan is great, or at a great height above the ſurface of the earth, the expence of a frame formed in the ſame manner, would be enormous, and in many caſes impracticable; but whether the arch be great or ſmall, high or low, a proper economy ought to be obſerved; and the leſs the expence in wood and workmanſhip incurred, ſo much the more advantage to thoſe concerned, and the purpoſe being obtained, ſo much more credit is due to the engineer.

It is again to be conſidered, on the other hand, that in order to ſave ſome expence, either in wood or workmanſhip, the frame or center, as we ſhall call it, is made too ſlight, and ſo unconnected in its parts, that the preſſure of the arch ſtones is greater than it can ſupport. The whole work is brought down, and the ſaving on the one part produces a more ſerious loſs on the other; ſo that both the workmen and proprietors agree, that it is better that the centre be too ſtrong than too weak; better have too much wood in it than too little. To aſſiſt the mechanic in this important affair, is the deſign of treating this article with particular attention; for which purpoſe we ſhall be at pains to acquire every aſſiſtance that can be collected, from the moſt experienced engineers, and from the reſearches and experiments of the moſt diſtinguiſhed philoſophers who have treated of ſuch arts as may enable us to elucidate the ſubject, and make it worth the attention of engineers and mechanics who may have occaſion to exert their genius in that line.

In the firſt place, it will be neceſſary to conſider the weight to be ſupported: 2dly, The quantity of the materials to be uſed, that ſhall be of ſtrength ſufficient to ſupport ſuch a weight: 3dly, The moſt effective method to apply theſe materials, as ſupported by the moſt approved authorities, or practiſed by the ableſt engineers. The weight to be ſupported is the arch-ſtones. Suppoſe an arch of 20 feet ſpan, (ſee figures for the arches, a new figure being unneceſſary). It has been ſhown under the article Bridge, that the arch can be raiſed to 30 degrees and upwards, without the ſupport of the center; after which it begins to reſt upon the frame of which the center is compoſed, if the arch is a ſemicircle, or ſemiellipſe; if a ſegment of a circle, it will preſs ſooner upon the center, and the more ſo the flatter the arch is. 1ſt, Suppoſe a ſemicircle; then there is 120 degrees of the arch to be ſupported by the center, the diameter ſuppoſed is 20 feet. One hundred and twenty degrees will meaſure 20.94393 feet; but as it is adviſable to give the advantage to the centre, we call it 21 feet in an arch of 20 feet ſpan. If the ſtone is of a durable and hard quality, perhaps an arch-ſtone of 12 or 14 inches might be of ſufficient ſtrength; yet it is not probable that any one would think of leſs than 18 inches for the thickneſs of the arch; for it will not have too heavy an appearance if it ſhould be two feet thick. We ſhall calculate the weight at 18 inches ſquare; the thickneſs of the ſtone is not here to be conſidered, as the weight of the whole is to be ſupported till the key-ſtone is driven: the ſpecific gravity of good freeſtone is 2.532, the ſolid feet in an arch of 120 degrees; the ſpan 20 feet is 21 feet, nearly as above. The ſtone 18 inches ſquare by 21 feet gives 47.25 ſolid feet; the weight by the above ſpecific gravity is 7477.3076 lb. averdupoiſe, about 66.753 cwt. being the weight that one rib of the center frame muſt ſuſtain, without warping, or by the preſſure on its haunches make it riſe in the crown; neither muſt it ſink under the preſſure: in either caſe the conſequences would be fatal, either in cauſing the arch to give way, upon ſtriking out the center, or in weakening it in ſuch a manner as to ſhorten its durability; being twiſted in its ſhape, the equilibrium would be deſtroyed, and the conſequence would be either to ſpring the key-ſtone, or, if that was prevented by the weight above it, the ſame weight would cauſe it to yield at about, or a little above, 30 degrees from the ſpring of the arch. From all which the neceſſity of the ſtrength and firmneſs of the center frame is evident.

If the arch exceeds 20 feet, ſuppoſe 50, the weight will evidently become greater, and an additional ſtrength neceſſary on that account; and likewiſe on account of its greater extent, the frame that would be ſufficiently firm at 20 feet would be ſupple at 50. To prevent any error on this account, another calculation for 50 feet will become neceſſary. In the ſpan of 50 the arch of 120 degrees meaſures 52.36 feet; ſuppoſe the arch-ſtone 2½ feet deep by 2, is five ſuperficial feet, multiplied by 52.36 is 261.8 ſolid feet, and at the above ſpecific gravity gives 41429.7154748 lb. averdupoiſe, equal to 369.908 cwt. Here the weight is increaſed upon the center frame, in the proportion of 66.5 to 369.9, that is, more than five times, beſides what allowance will be neceſſary to make for the difference of the ſtiffneſs of the center frame; both which will be conſiderd in their proper places.

Let us now conſider what will be the increaſe of weight upon a ſpan of 100 feet. The riſe of the arch, before it preſſes on the center frame in a ſemicircle, being in the ſame proportion, the arch of 120 degrees in 100 feet ſpan meaſures 104.719 feet; the arch-ſtone may be ſuppoſed abundantly ſtrong of 4 feet length, for the depth of the arch, and 3 feet broad, which makes a ſuperficies of 12 feet, and multiplied by 104.719 gives 1256,628 ſolid feet, the ſpecific gravity, that is, the ſtone is ſuppoſed of the ſame durability gives 198,861.381 lb. averdupoiſe, equal to 1775.548 cwt. about five times more weight than upon the arch of 50 feet ſpan. If the arch is 130 feet ſpan, 120 degrees meaſure 136.13556 feet. Suppoſe the arch-ſtone 5 feet, as in the arch-ſtones of the bridge over the Dee at Aberdeen, at leaſt they are between 4½ and 5 feet. The Aberdeen granite is a very hard ſtone, and perhaps exceeds the ſpecific gravity above. The arch-ſtone is here ſuppoſed to be 5 feet by 3, equal to 15 ſquare feet, multiplied by 136.13556, gives 2042.0334 ſolid feet. According to the above ſpecific gravity, the weight to be ſupported till the key-ſtone is drove, is 2885.2838 cwt. The weight of the key-ſtone in the whole of the above may be deducted.

As center frames muſt likewiſe be uſed for iron bridges, we ſhall conſider them, and take the ſpan 236 feet, ſtill ſupporting a ſemicircle.

It may be proper to take the weight that it would be if the arch were the ſegment of a circle, the ſpan of the arch 236, the height above the ſpring of the arch, or the verſed ſine of the arch, 34 feet, in which caſe the diameter of the circle would be 444 feet nearly; the arch-ſtones in this ſegment would preſs upon the center-frame, at about 18 feet from the ſpring of the arch. Suppoſe the arch-ſtone 5 feet by 4, equal to 20 ſuperficial feet, the whole meaſure of the arch is 444.154 lineal feet, the ſolid content is 4131.84 feet, and weight 318.689 tons; but the weight of the iron was only 260 tons. It may not be improper here to obſerve, that in a ſtone bridge of that ſpan, 5 feet of arch-ſtone would be too ſmall to ſuſtain the arch. It may perhaps be admitted, that it would be ſufficient to ſupport its own weight; and if ſo, the arch being ſmoothed above, a ſecond arch of a five-feet ſtone may be thrown over above it. Theſe two together may form a ſtronger arch than a ſtone of ten feet depth would do. And thus a ſtone arch may be extended to any ſpan, and made of abundant ſtrength; and experience has ſhown its durability to withſtand the weather. Thus the old London bridge has performed its faithful ſervices to the public for 600 years: that it was an incumbrance in paſſing up and down the river, and clumſy in its conſtruction, were owing to the taſte of the times; perhaps few will be found that would be willing to inſure an iron bridge againſt the ruin occaſioned by the weather for the ſame time, or perhaps much above one-half that time. But this is not a fit place to enter into the full diſcuſſion of this ſubject. To return to the weight preſſing upon a center-frame. Having now taken a view of the weight to be ſupported, it comes next to be conſidered what ſtrength of wood is neceſſary to reſiſt this force, and the moſt proper and commodious manner of combining the parts. To determine this, we muſt have recourſe to ſuch experiments as have been made for trying the ſtrength of different ſpecies of ſtone and wood.

Experiments have been made to aſcertain the ſtrength of timber, and many of them appear to have been conducted with great care and attention. Some of theſe the reader will find collected and detailed under the article *Strength of Materials*. We ſhall here ſtate the reſult of ſome of the curious experiments which were inſtituted by the Count de Buffon to aſcertain this point. According to theſe experiments, the batten of five inches ſquare, whoſe length was 14 feet, and which ſupported a weight of 5300, which may be called its breaking force, ſhould have double the ſtrength of a batten of 28 feet long. But it has a great deal more. The latter by the experiment is equal to 1775 only; whereas the half of 5300 is 2650. But it is to be conſidered, that the power of the lever is in proportion to its diſtance from the fulcrum; this power ariſing from the weight of the log, is the weight of one foot of wood acting as a weight at a diſtance from the fulcrum. The log increaſes in its power to break by its length: 12 inches of this log, five inches ſquare, weighs about 10.4 lb. ſomewhat more or leſs; and 10.4 lb. at 13 feet diſtance, acts with a force of 135.2 lb.: this we conſider the laſt term; and 0, the point of fracture, is the firſt term: the firſt and laſt term, multiplied by half the number of terms, are equal to the ſum of all the terms; that is, $135.2 \times 6\frac{1}{2}$, amount 878.8 lb. added to 1775, equal 2653.8; ſo near to the half, that the difference may eaſily be accounted for, from the real weight of the wood on which the experiment was made; and our taking the weight from tables of ſpecific gravity, or the ſuppoſed 60 lb. To take another example, a batten of nine feet is double the ſtrength of one of the ſame ſize of 18 feet long. The weight that breaks a batten of nine feet, five inches ſquare, is 8308lb.; the half is 4154, but by the experiment, 3700lb. break the batten at 18 feet. N. B. The weight being laid upon the middle, $9\frac{1}{2}$ is the number of terms, one-half is 4.625. Seventeen feet one-half is $8\frac{1}{2}$; 10.4lb. multiplied by $8\frac{1}{2}$, is 102×4.625, half the number of terms, is $471.25 + 3700$, is 4171.25, ſomewhat greater, but which is ſo near, that the ſmalleſt accident for failure, not diſcernible in the wood, will occaſion the difference. Now to reduce the experiment of this given ſize to any other of greater dimenſions; ſuppoſe one foot: ſimilar ſolids of the ſame altitude are to one another as their baſes; that is, 25, the baſe of the five inch ſquare, is to 144, the baſe of the 12 inch ſquare, as the weight that would break the batten of nine feet, to the weight that will break another of the ſame nine feet length, and of one foot ſquare (5. 6. El. 12.), that is, as the baſe 25 is to the weight 8308, ſo is 144 to 47854lb.; equal 213.8125 ton, and the proportion as above, for greater or leſs length of logs or ſpars. As we have no experiments made of logs of 12 inches ſquare; unleſs there is ſomething in the texture of the fibres, in pieces of different diameters, we have every reaſon to conclude, the above proportion will give the proper ſtrength of the material uſed. It muſt, however, not be forgot, that the pieces upon which the experiments were made, were nicely choſen for the purpoſe. It will ſcarcely be practicable to find a piece of 12 inches ſquare, and even of nine feet length, equally well adapted to bear a proportionable ſtrain; and much more difficult to find a piece of ſtill greater length. Theſe experiments and proportions afford a ſafe criterion for proper limits to be attended to in practice. In this, we do not mean to apply ſuch a load upon the beam as will break it; we intend the beam to ſupport the load, without giving way or yielding to it.

In the ſame experiments, we are told by the author, that two-thirds of the weight broke the beam in the ſpace of two months; that one-half the weight gave a ſet or bend which it did not recover, but ſhewed no farther tendency to break; that one-third of the weight, after long continuance, did not give it a ſet; but the weight being removed, the beam returned to the ſame poſition as before it was loaded. Betwixt one-third, and the half of load or weight that would break the beam, is the ſtrength we allot to it for permanent uſe. Before we proceed to put the above obſervations into full practice, let us examine whether the log is neceſſary to be ſquare to give it the greateſt ſtrength: practice, in a great meaſure, determines that it is not. It is, however, neceſſary to inquire what breadth to a given depth is ſufficient as a *maximum* that we ought not to exceed; or what is the *minimum* that we may uſe, ſo as not to loſe the principal intended effect. Belidor has made a ſeries of experiments on the tranſverſe ſtrength of bodies, which are detailed in his *Science des Ingenieurs*, but the ſpars are only of one inch, not exceeding two inches in breadth or thickneſs. Among theſe, we ſelect one ſpar two inches breadth, one inch depth, and 18 inches length; which at the *medium* of three trials was broken, lying looſe at both ends, by 805 lb. Another one inch board, two inches deep, and 18 inches long, broke with the force of 1580 lb.; nearly in the proportion of the ſquare of the depth, being only a diminution of 20lb. weight. In the preſent caſe, the quantity of matter is the ſame in both.

It may therefore be concluded from this experiment, that a batten of any depth, and one-half breadth, is equally ſtrong in that poſition as if it had been ſquare timber; and that the ſtrength is according to the depth, if the breadth is only ſuch as that it does not yield in that direction. And hence the advantage in point of economy; for if the piece is ſet upon its edge, ſuppoſe nine inches deep and one broad, provided that by ſtraining the piece in depth, it ſhall not yield in the lateral direction, it will bear as much ſtrain as if nine inches ſquare. The experiment may be performed upon a ſmall ſcale. Suppoſe five inches, and one inch broad, the thin ſection may be encloſed at different diſtances with pieces five inches ſquare. Suppoſe at the diſtances of 1, 2, 3, &c. fig. 1. Plate CXXXVIII. and the weight applied that broke the five inch ſquare of the length of 14 feet, viz. 5300 lb.

All the experiments which have been alluded to above were made upon ſcantlings of ſound oak. But it has already been obſerved, that in practice, ſuch pieces cannot always, if at all, be ſelected. But the practical mechanic, confining himſelf to between one-third and one-half of the abſolute ſtrength, according as his judgment directs him, reſpecting the ſoundneſs of the piece he uſes; there can be no doubt, that, upon occaſions, he will be convinced, that he cannot, with ſafety, allow even one-third of the abſolute ſtrength, but muſt take it conſiderably below that proportion.

As to other ſpecies of wood, trials have alſo been made; and the reſult from different experiments has occaſioned ſome deviation. We are told that Buffon makes fir about $\frac{6}{10}$ths of the ſtrength of oak; Parent $\frac{10}{12}$ths; and Emerſon $\frac{2}{3}$ds, all of them different. The difference between Buffon and Parent is $\frac{1}{10}$th; between Parent and Emerſon is $\frac{1}{6}$th; and between Buffon and Emerſon is $\frac{2}{5}$th. It is eaſy to conceive that the different ſtates of the wood, and different circumſtances in the ſame ſpecies of fir and oak, will make a conſiderable difference; although the ſame perſons were employed on the ſame materials, the experiments would probably vary; much more, may it be allowed that at different times different ſtates of the wood muſt make the reſults different.

The experiments made by different perſons vary in their amount. Belidor's experiments agree one part with another, and ſo do Buffon's, but differ in their reſults from Belidor's. Belidor's ſlips of oak are only of one inch ſquare, and Buffon's are from four to eight inches ſquare, and from 7 to 28 feet in length. When the one is reduced to the ſtandard of the other, they do not agree: the difference may ariſe from various cauſes. We know that there is a difference in the ſtrength of oak of different growths, and from different ſoils, as well as in other ſpecies of wood; there is likewiſe a difference in the degree of ſeaſoning of the wood. Buffon gives the weight of his wood, Belidor does not. If Buffon's log or batten, four inches ſquare, weighs about 60lb. that is, about 77lb. the ſolid foot; whereas a ſolid foot of dry oak will not weigh above 60lb.: but Buffon acknowledges that his wood was in the ſap, as vapours iſſued at both ends in the bending. Theſe differences may make all the odds in the breaking, unleſs the proportion was eſtabliſhed to be, as the ſquares of the diameter of the battens; but this is not the caſe, for in Buffon's experiments, the ſquare of four, to the ſquare of five of the ſeven feet batten, the breaking force is 8300 lb.; but the experiment gives it 11525; that of ſix inches ſquare 16:36::5312.11952; exp. 18950. In the ſeven inch ſquare 16:49.5312.16268; exp. 32200. In the eight inch ſquare 16.64.5312:21248; exp. 47649, the difference between four and five inch ſquare is one-third part of the experiment weight; the difference between the four and ſix, is ſomewhat more than one-third the experiment weight; and in the ſeventh, the difference is a little leſs than half the experiment weight; between the ſeventh and the eighth the difference is greater than half the experiment weight.

There is likewiſe a difference at the different lengths; for it does not appear that the different lengths bear a proportion to their parts; a batten of four inches ſquare of ſeven feet length, is expected to be double the ſtrength of one of the ſame dimenſions of 14 feet length, that is, the one of 14 feet length, is expected to break with one half of the weight, that breaks the ſeven feet batten; but we find it much leſs; but when it is conſidered that the weight of the materials acting at a greater diſtance from the centre of motion, this muſt be taken into the account, and added to the weight of the breaking force. For example, the batten of five inches ſquare and 12 inches length, weighs 13.368lb. at the rate of 77lb. per ſolid foot. This weight, acting upon the batten of 14 feet, taking the amount of the whole in an arithmetical ratio, is $13.368\times52\frac{1}{2}$,=701.5lb. acting upon the whole, added to 5300, the breaking force 6001. The breaking force, at ſeven feet, is 11525, one half is 5762.2.5 one twenty-fourth part greater than the half. The batten of ſix inches ſquare, the breaking force at 14 feet is 7475, the weight of 12 inches of this batten is 19.25lb. at 77lb. per ſolid foot; the acting force of this weight at 14 feet length is $19.25\times52\frac{1}{2}$, is 1010.625, added to 7475, equal to 8485625. Now the breaking force of ſeven feet length is 18950; one half is 9475, the difference is 989, that is, nine and a half times leſs than the half. In the ſeven inch batten of ſeven feet length, the breaking force is 32,200lb. and of 14 feet length, the breaking force is 13,225. The weight of 12 inches of the ſeven inch ſquare is 26 2lb. acting upon the 14 feet length, is 1370.5+1322.5=1460olb. which is one-ninth leſs than the half. Again, 12 inches of the eight inch batten, weighs 34.2lb. at 77lb. per ſolid foot, acting upon the 14 feet length, is 1796lb. added to 19775, the force that broke it at 14 feet length, is 21575lb. about one-tenth part leſs than the half of 47,649lb. which broke it at ſeven feet length. From the above compariſon, it may be allowed, that the difference of the force that broke the ſpar at ſeven feet, and that which broke it at 14, ſo far as it differs from the half, is accounted for upon philoſophical principles; and when we conſider that the ſpars or battens cannot be ſuppoſed to be mathematically exact in their meaſure, and that a difference in point of breaking, may be accounted for from that cauſe; but further, it may be obſerved that the weight of the materials is not equal in the ſolid foot. For example, the ſpar four inches ſquare, and ſeveral feet in length, weighs 60lb.; that is, at the rate of 77.14lb. per ſolid or cubic foot, the eight feet ſpar at the rate of 76.5lb. do.; the nine feet ſpar at the rate of 77 feet; the 10 feet ſpar at the rate of 75.6; the 12 feet ſpar at the rate of 75lb. per cubic foot; which difference of weight, with the difference of exact mathematical meaſure, may fully account for all the difference that takes place in the manner of accounting for the above-mentioned difference of the weights of breaking, at 7 and 14 feet; as alſo the difference that takes place between 8 and 16; 9 and 18, &c. the experiments being made upon green wood, cannot be approved of; they ought to have been made of ſuch ſeaſoned wood as is fitted for mechanical purpoſes, of which none of this kind can be uſed; or if experiments are made with unſeaſoned wood, as being of the greateſt ſtrength, they ought likewiſe to have been made with dry wood ſeaſoned for uſe. A cubic foot of dry oak will not weigh much above 60 lb. Thoſe ſpars upon which the experiments were made, muſt have been very green, and very unfit for mechanical purpoſes, which gives an unfair account of the ſtrength, when in a proper ſtate for uſe. But experiments were made with wood of different weights, which may be ſuppoſed better ſeaſoned. For example, the ſeven feet ſpar that weighs 56lb. that is, 72lb. per cubic foot; the nine feet ſpar is at 71 lb. per ſolid foot, and the 10 feet ſpar at 73.8lb. per ſolid foot, none of which are ſeaſoned wood. And yet it is not mentioned which of theſe were uſed. This may be adduced as a very good reaſon why the variations were ſo great.

We ſhall now conſider the force in bruiſing materials, according as we may be directed by experiments made in this way. And 1ſt upon that of ſtone, which will in ſome meaſure lead to the preſſure in the ſame direction upon other materials.

The experiments ſelected from M. Gauthey, engineer, in erecting the bridge of Chalons ſur Saone, (tom. iv. *Rozier Journal de Phyſique*, November 1774,) are now to be conſidered.

Experiments Selected.

	Length of the Stone.	Breadth.	Superficies.	Force.	Upon each ſquare line.	Proport io.	Difference.
		Lines.		lb.			
Hard Stone	8	8	64 4/9	46	10 2/3	12	2/13
	8	12	96 2/3	164	27	24	1/8
	8	16	128 7/8	281	35 1/3	36	1/34
Soft Stone	9	16	144.1	35	3 2/3	4	2/32
	9	18	162.1 1/8	53	5	4 1/2	1/9
	18	18	324.2 1/4	183	8 1/2	9	15/18
	18	24	432.3	131	12 2/3	12	21/28

In general, the force is greater as the ſurfaces increaſe, but a regular proportion to fix upon a theory is not found; but the laſt line in the table, the weight that cruſhes the 432.3 ſurface, muſt be greater than 131, the ſtone being of the ſame quality: if in the proportion of 8½ to 12⅔, the cruſhing weight will be 272 7 inſtead of 131.

The meaſures here taken are cubic, and the preſſing force is upon cubic lines, the thickneſs one line; where the preſſure is upon a ſquare foot, it is likewiſe to be underſtood one foot deep, or upon a cubic foot; the ſtone uſed, he terms *Givry ſtone*, of which he gives its abſolute force to be 870911, that it will bear 663552lb. In the cubic foot of ſoft ſtone the ſtrength is 248832lb. The proportional force of the hard and ſoft is 2¼ to 1.

A cubic foot of a ſtone fixed in a wall, and projecting one foot, was broken by a force of 55728lb. And a cubic foot of ſoft, by 10080lb. the proportion 5½ to 1.

A cubic foot of hard ſtone, ſupported upon two fulcrums at 1 foot diſtance, was broken by 205632lb. ſuſpended from its middle; and the ſoft by 38592, the proportion about 5⅓ to 1.

In fine, a cubic foot of the hard ſtone was torn aſunder by 45,500lb.; and the ſoft by 15,850lb. the proportion 2¾ to 1. Thus far Gauthey's account.

It is to be obſerved, that the above table does not ſtrictly correſpond with itſelf; for the proportion upon the ſquare line, or 1/12 of an inch, in place of 10⅕ is upwards of 11. Now the increaſe of force which cruſhes 96 ſquare lines, and 128 one line thick, is 7.8 oz. nearly upon the ſquare line, that is a little more than ⅕ of 35 oz. upon the ſquare line; then as 128 ſquare lines is to 4496 oz. ſo is 144 ſquare lines to 5058, to which add one fifth, viz. 1011⅓, this makes 6069¾ upon the ſquare inch, and this multiplied by 144, the ſquare inches in a foot, is 874,022.4 oz. but Mr Gauthey ſays, that the ſquare foot of ſurface of one foot deep, is of the ſtrength of 870,911lb.

Again, there is 20,736 ſquare lines in a ſquare inch, the force upon a ſurface of 64 ſquare inches, being about 11.5 upon each ſquare line, is 238,464 oz. upon the ſquare foot. Upon the ſurface of 96 lines, 27 oz. to the ſquare line, gives 559,872 to the ſquare foot. Upon the ſurface of 128 lines, 35⅓ to the ſquare line, is 878,806 to the ſquare foot, the proportion of 238,464 oz. to 870,911 is about 53¼ nearly, and of 559,872 to 870,911 is ⅔ nearly; but by the experiment the number 870, 911 is lbs. upon the ſquare foot, the other numbers are only ozs. The variation between the firſt difference, and between the preſſing force of 6069¾oz. upon the ſquare inch, makes in that proportion 874,022 oz. The increaſe of force from one ſquare inch, to one ſquare foot, muſt be 1/18 part of what the above experiment upon the ſquare foot produces. Further experiments upon this therefore become neceſſary. In the mean time, we have no reaſon to doubt the experiment upon the ſquare foot, or upon the ſmaller parts; intermediate experiments only can make them accord. One example adduced is of conſequence. A pillar in the church of All Saints, in Angers, of 24 feet height, and 11 inches ſquare, ſupports a weight of 60,000lb. that is ⅕ being added 85685.9 upon the ſquare foot, which is ſaid not to be 1/7 part of the load that would cruſh it. From this it is evident, that the load it ſupports exceeds the weight of an arch of 50 feet ſpan, of a cemicircular form; the arch-ſtones being 2½ feet long, or depth of the arch, and 2 feet in breadth. It is aſſerted under the article Bridge, that inſtead of an arch ⅕ of the opening or 10 feet thick, that a pier of 2 feet thick would be ſufficient, but that it is given twice the length of the arch-ſtone, that is 5 feet thick in place of 10; but from this example, it is five times thicker than neceſſary, and has therefore ſuperabundant ſtrength, allowing even for the force of a current. How ſuperfluous then will theſe clumſy piers be reckoned, whoſe ſole effect is a uſeleſs obſtruction to the water! But as our principal deſign at preſent is upon the ſtrength of wood, in proſecution of this inquiry, we have paid particular attention to the ſtrength of this material, in the tranſverſe direction, in ſo far as it can be ſupported by experiment. Before we proceed to make particular application to its uſe, it will be neceſſary to conſider its ſtrength or power of reſiſtance in its breadth and thickneſs. In this it may be with ſafety averred that ſuch force as will bruiſe or cruſh its fibres, although only of $\frac{1}{10}$ or $\frac{1}{12}$ of an inch; the ſame weight continued will produce the ſame effect upon the next ſtratum, till the whole piece is bruiſed, and its coheſive power overcome. This is ſupported by the experiments of celebrated mechanicians, as thoſe of Buffon, Muſchenbroek, Bouguer. Muſchenbroek, in his *Eſſai de Phyſique*, ſays, that a piece of ſound oak $\frac{27}{100}$ of an inch is torn aſunder by 1150lb; and that a plank 12 inches broad, and 1 thick, will juſt bear 189,168lbs. Theſe give for the coheſion of an inch 15,755, and 15,763lbs. Bouguer in his *Traité de Navire* ſays, that it is very well known that a rod of ſound oak, of $\frac{1}{4}$ inch ſquare, can be torn aſunder by 1000lb. this gives 16,000 for the ſquare inch. Bouguer ſpeaks with certainty, that $\frac{1}{4}$ inch ſquare of ſound oak can be torn aſunder by 1000lb. If we reduce the above proportions of the experiment, it will appear, that the force will be much greater than 16,000, to tear aſunder a piece of ſound oak of one inch ſquare. It muſt in the mean time be allowed, that Buffon's experiments being upon a larger ſcale, can be followed with more ſecurity than thoſe upon a ſmaller ſcale.

But, after all, we have not yet got ſufficient data to form a criterion for an arch; nor can this be expected till we have more preciſely aſcertained the ſtrength of an arch above a right line, parallel to the horizon.

In the firſt place, as an arch is in form, one part of it towards the perpendicular, and the other towards a horizontal line; the force that it will ſuſtain, is between that force that a body will carry in the perpendicular, and that which produces a fracture upon any material in the horizontal direction. If the perpendicular is greater than the horizontal line, it will have more of the ſtrength of the bruiſing force, than of the tranſverſe fracture; and the force may be expreſſed by the ratio compounded of the bruiſing or cruſhing force, and that of the tranſverſe fracture; or not improperly expreſſed, as it has been denominated by others, the abſolute and relative force.

Unfortunately we have not yet a ſufficient variety of experiments to aſcertain the abſolute force, as thoſe made are only upon a ſmall ſcale; and the number is not adequate to form a proportion of the increaſe for the force that will cruſh a piece of wood of $\frac{1}{10}$, or as the French philoſophers have done moſt this way, we take their meaſure $\frac{1}{12}$ of an inch, or one line, and from that to an inch; but the force required is found to be greater than that of the ſquare of the diameter, as alſo the force to produce a tranſverſe fracture, or to give the relative ſtrength. This increaſes in a greater *ratio* than that of the ſquare of the diameters; for in the above experiments, the weight that broke a batten 4 inches ſquare, was to that weight which broke an 8-inch ſquare batten, each of the length of 7 feet, more than double of the ſquare of 4 to the ſquare of 8 as above; we are, therefore, much limited as to an exact procedure.

At the ſame time, by keeping the experiments in view, and the obſervations made upon them, we ſhall be able to give ſuch a *ratio*, as to the neceſſary ſtrength, as will furniſh the ingenious artiſt with a pretty ſure principle to act upon, and prevent his uſing ſuperfluous materials, either in their application to horizontal right lines, or inclined in the right lined direction, or in curves.

If we attend to the weight that cruſhes one inch of ſound oak, by Muſchenbroek's experiments, we find that it is 17,300lb. but, if computed from the increaſe, being as the ſquares of the diameters, it is only 16,000lb. but it has been found as above, that the power to break, or make a tranſverſe fracture in the ſame wood, of the ſame length, of different diameters, if a conſiderable difference in diameters is taken, the difference of weight is twice that produced by the ſquare of the diameter. This compariſon makes the proportion between the ſtrength of ſtone, and that of wood, to be as 17,300 is to 6048, or 1 to 2¼ nearly. Thus we may with a ſufficient degree of accuracy ſubſtitute the one for the other in point of ſtrength, and form a proportion between the arch and the ſtrength of a horizontal line. As ſeveral experimentaliſts agree, that a ſquare inch of wood can be cruſhed or pulled aſunder with a weight of between 16,000 and 17,300lb. and that a piece of wood one inch ſquare, 18 inches in length, can be broken by 406lb. or at 12 inches by 609, or at 6 inches by 1218; attending to the addition as mentioned above, which has been proved by compariſon of experiments, to be upon the principle of the lever. If, then, the geometrical mean is taken between the elevation of the arch, as preſſure or abſolute ſtrength, and the length of the horizontal line, this mean will be the ſtrength of the arch above the horizontal line; for it is evident, that ſo much as the piece of wood is elevated towards the perpendicular, ſo much the nearer it approaches to its abſolute ſtrength, and by ſo much as the arch is flatter or the piece of wood leſs inclined, the nearer it is to a ſtraight line, and ſo much the more reduced to its relative ſtrength; the poſition of the arch, therefore, muſt be in the ratio compounded of theſe two.

Having now eſtabliſhed the principles, let us endeavour to apply them to practice, in forming a center or ſupporting an arch, to produce the intended curvature or mould for an arch, of any intended ſpan, and at the ſame time, have ſtrength to ſupport the ſame. Several ingenious artiſts have not only formed, but have written and laid down principles for forming theſe moulds, both with regard to ſtrength and economy; at the ſame time we have not found any that have treated the ſubject upon principles that are fully eſtabliſhed. We have, therefore, been the more particular, according to the principles laid down. 1ſt, We have aſſigned the weight to be ſupported, as eſtabliſhed by uncontroverted principles: And, 2dly, eſtabliſhed the ſtrength of wood as to its thickneſs or diameter, that is ſufficient to ſuſtain ſuch weight; which we have ſupported by the moſt approved experiments, comparing one with the other; and in the third place, we have conſidered the effects when the materials are applied in the horizontal direction, or elevated in any degree toward the perpendicular.

In a work of this kind, it is not only neceſſary to lay before our readers well grounded principles, and a well ſupported theory, but along with theſe, the different opinions, and various modes uſed by the moſt diſtinguiſhed artiſts, who have exhibited their plans to the public, together with the principles on which they were founded, and the ſucceſs they have met with, in anſwering the purpoſes propoſed.

Among the moſt diſtinguiſhed who have treated this ſubject, we may conſider Pitot, a member of the Academy of Sciences, who wrote about the beginning of the laſt century. His method undoubtedly ſhows conſiderable ingenuity; but, at the ſame time, we muſt obſerve that he has been rather too profuſe in the quantity of materials which he has employed.

To lay his plan of operation before our readers, we ſhall give a figure ſhowing the conſtructions. The arch of the circle or ellipſe being formed; as little or no weight lies upon the center, till between 30 and 35 degrees of the arch, a ſtretcher is extended at this height, to the ſame height on the oppoſite ſide; two ſtruts ſupport this ſtretcher from the ſpring of the arch; upon the upper part of the ſtretcher, immediately above, or a little within the upper end of the truſs on each ſide, two ſpars joining upon the king-poſt, ſpring from about the middle of the arch, the ſtretcher being divided into four parts. Another ſtrut ſprings from the riſe of the arch, meeting the ſtretcher at this fourth part, from each ſide of the arch; theſe laſt ſtruts are joined by a tie-beam, which gives additional ſtrength to the firſt ſtretcher; upon theſe, on the upper ſide of the ſtretcher, two ſpars join the king-poſt, a little below the other; theſe ſpars are joined by bridles or croſs ſpars, from the circular arch, to the lower ſtrut; ribs of the ſame formation being placed at proper diſtances, according to the width of the bridge, and joined by bridging joints, which may be of greater or leſſer ſtrength, according to the ſpan of the arch; and of conſequence the weight it has to ſupport. Pitot is the firſt writer who has given us any account of the method of forming frames, according to the above general deſcription. If no reſts are left at the ſpring of the arch, as a baſe for the center to reſt upon; let AB, fig. 1. Plate CXXXVIII. be the ends of two planks raiſed from the foundation, upon which the center may reſt; let CD be the ſtretcher, extended about 35 or 40 degrees from the ſpring of the arch; or, as little weight reſts upon the center till that height, the ſtretcher may be as high as 45 degrees; let AE, AG, BD, BG be the two ſtruts on each ſide; from each extremity of the center, let BE, AE, be fixed to the ſtretcher near C, and D, and AG, BG, at ¼ of CD; their ſtretcher or tie-beam GG, equal to one-half of CD, the bridles, 1, 2, 3, &c. from A to C, and from B to D, are intended to prevent the arch from yielding; from A to C, and from B to D. The ſtruts EF, EF, meeting the king poſt K in F, and the interior ſtruts GH, GH, meeting the king-poſt in H, ſupport the bridles 4, 5, 6, on each ſide of the king-poſt; their uſe is to ſtiffen the frame of the center, which ſupports the upper and more weighty part of the arch.

The arch for which Pitot allots this center, is of 60 feet ſpan; and the arch ſtones ſeven feet in length, the weight of a ſolid cubic foot he makes 160lb. The Portland ſtone is admitted to weigh 160lb; but we do not find any other freeſtone of ſuch weight. It is however to be conſidered, that the Paris foot is 12.788 of our inches, that is, a little more than 12¾ths of our meaſure, which will make a difference of the weight upon the foot; as alſo their lb. is lighter than ours about 1.2 oz. by which the ſtone here mentioned is not better than ours. In a matter of this kind, ſuch exactneſs is not neceſſary. As was propoſed, we firſt conſider the weight to be ſupported by the frame, and here it is evident from the figure that no ſtrain lies upon the frame below C; the arch is raiſed, or can be raiſed to this height, before the frame is ſet; therefore the perpendicular C *c* determines the limits of the abſolute preſſure upon the frame. The triangle C *e c* preſſes on the frame, and the triangle C *f g* adds to the lateral preſſure; the weight of the arch, that actually preſſes upon the frame, is contained between the perpendicular lines C *c*, D *d*; no more can preſs upon the center frame. The part of the arch below C will reſt upon the abutment raiſed upon the pier; but if it is inſiſted that there is a preſſure upon the lower part of the center frame, what can only poſſibly reſt, or preſs upon it, muſt be contained between the parallels C *c* and *f g*; although it will be admitted, that the arch can be raiſed to the height C, without the center frame; but to indulge ſuch as ſay it is not adviſable to do it, we will admit what lies between theſe parallels to preſs upon the frame. Now to determine the weight of theſe parts of the arch, the diſtance between the perpendiculars C *c*, D *d* is 53 feet; the archſtone is 7 feet, and admit it to be three feet broad, $53 \times 7 \times 3 \times 160\text{lb.} = 178{,}080\text{lb.}$

To determine the area between the two parallels C *c*, *f g*, the line *f g* perpendicular to the diameter AB, is 13½, the baſe is 9½, and C *f* perpendicular to it is 7 feet, the area is 33¼ feet; C *c* the baſe of the triangle C *f c* is 7.2, and *f c* is 7; the area is 25, the difference is 8¼. If this difference had been the exceſs of the triangle C *f c* above the triangle C *f g*, it would have been a preſſure upon the frame; but as it is the reverſe, the preſſure is upon the abutment. This diſtinction is requiſite to be taken notice of, that an unneceſſary expence of wood and workmanſhip be not expended where it is unneceſſary; as well as its being unworkman-like, or having an appearance of ignorance in the engineer.

Let us now inquire, what ſtrength of materials is ſufficient to ſupport this weight. It has been laid down as a principle, that the parts of wood in an arch act upon one another by their abſolute ſtrength; but are liable to the tranſverſe fracture; in proportion to the length of the piece, in a ſpan of 60 feet, the length of the piece may be 7 feet without ſenſibly impairing its ſtrength, in reducing it to the round; and experiment gives the relative ſtrength of 7 feet to be 47649lb. by 8 inches ſquare. It has been formerly illuſtrated from experiments, that the ſtrength is according to the depth, with this precaution, that the breadth or thickneſs be ſuch, that it is prevented from warping, the abſolute ſtrength being nearly, by laſt experiment mentioned, as the ſquares of the depth. The abſolute ſtrength to the relative force has been found nearly 60 to 1, although by ſome it is ſaid to be only 42 to 1; the abſolute ſtrength of the plank 12 inches broad by one thick, is 189163lb.; if two inches, it would be no more than 189163lb. If it had been 8 inches ſquare, then every 7 feet of the arch might be broken with the weight 189163lb.; but the whole weight of the arch is only 178080lb. that is, 11080 leſs weight than what that part of the frame would bear; but 7 feet is only about one ſeventh part of 53; the frame is therefore of ſufficient ſtrength to ſupport the whole weight of the arch when equally divided along its whole length. This is not the caſe with the center frame of an arch, as it is loaded at one place, and not at another; it is therefore apt to yield between the parts where the load is laid; that is, it may riſe in the middle, and thus change the form of the arch; for the center frame is not only intended to ſupport the arch, but likewiſe to preſerve its true form; for this cauſe ſome ſtruts may be neceſſary to prevent its putting the arch out of ſhape. To remedy this, where the arch begins to preſs upon the frame at C, draw the chord line C *c*, fig. 2. which acts as a tie-beam to the arch, from C at 35 degrees to *c* at 51 degrees, as beyond this, if the arch frame had been permitted to alter its ſhape, it would begin to be reſtored to it, at leaſt the force would tend that way. At that part of the arch, where its weight begins to flatten the frame, as at 2, draw the ſtretcher 2, 2, which likewiſe acts as a tie-beam, and gives ſupport to the bridle 1, on one ſide, and to 3 the bridle upon the other ſide, from D*d*; and thus the arch *c d* is prevented from ſinking by the tie beams *e d*. This will effectually prevent any warping or yielding of the frame, notwithſtanding the enormous load from the ſize of the arch-ſtones.

But it is neceſſary to attend to the relative ſtrength of different kinds of timber of which frames may be conſtructed. The relative proportion of the ſtrength of oak and fir has been aſcertained by different experiments; and although the reſults do not exactly agree, yet the mean or leaſt proportion may be taken. Let us take $\frac{6}{10}$, that of Buffon. Now to reduce a frame of oak to one of fir of equal ſtrength, divide 8 inches, the diameter of the oak, by $\frac{6}{10}$, the relative ſtrength of fir, this gives $1\frac{1}{3}$ inches. Allow $1\frac{1}{2}$ inches. The depth of the frame will then be $9\frac{1}{2}$ inches by $\frac{1}{3}$ or $\frac{1}{2}$ inches in breadth; that is, $9\frac{1}{2}$ by $2\frac{1}{2}$ inches. In this way the ſtrength of the fir arch is rendered equal, and by the additional allowance ſuperior, to the oak in ſtrength, and of leſs expence in wood and workmanſhip.

We have here taken the moſt ſimple method of inveſtigation and computation, that every mechanic, whether ſcientific or not, can eaſily follow it in every ſtep, and judge of the propriety or impropriety of what is advanced.

It will now be neceſſary to follow Mr Pitot in eſtimating the quantity of materials which he allows. The ring of his arches conſiſts of pieces of oak 12 inches broad and ſix thick. The ſtretcher CD is 12 inches ſquare, the ſtraining piece GG is likewiſe 12 inches ſquare, the lower ſtruts 10 inches by 8; the king-poſt 12 inches ſquare, the upper ſtruts 10 by 6, the ridges 20 by 8, French meaſure. Pitot allows the ſquare inch to carry 8650lb. that is, one half of the abſolute ſtrength, which is aſcertained by experiment to be 17300lb nearly, and not by the ſquare of the diameter, which would be only 16000lb. But on account of knots he reduces it to 7200lb. per inch. He then computes the whole load upon the frame to be 707520lb. which is the weight of the whole arch-ſtones, ſuppoſing each to be 3 feet broad, and the whole to preſs upon the frame. This comes ſo very near, that it would be needleſs to diſpute about the difference. We have ſhown that no more than 178080lb. preſſes upon the frame; but we are not ſo fully ſatisfied as to the weight that reſts upon the center. Pitot ſuppoſes it to be $\frac{4}{14}$ths of the whole weight; but he has aſſigned no reaſon for this conjecture. Mr Couplet aſſumes that it preſſes by $\frac{4}{9}$ths. Another writer, who makes ſome comment upon the whole, ſays that $\frac{4}{14}$ths is nearer the truth than $\frac{4}{9}$ths, but gives no reaſon for his opinion, which ſeems to be equally vague as the other. The preſſure here allowed, and the reaſon of aſſigning ſuch a preſſure, have been already explained. Our readers, therefore, have it in their power to examine the principles, and decide for themſelves.

It has been aſſerted by ſome, that the arch does not preſs upon the center frame below C. At the ſame time, were we inclined to diſpute this opinion, we might ſtate our objection in the following manner: Suppoſe the area of the triangle C *c f* was equal to the area of the triangle C*f g*, ſo that the friction above would make the triangle C *c f* reſt upon the ſide *c f*; and as the triangle C *f g* is greater than C *c f* in the proportion of $33\frac{3}{4}$ths to $25\frac{1}{3}$d, the coheſion of the parts will determine the intermediate ſpace between C*c* and *g f*, to reſt upon the abutment as has been ſaid, and not on the perpendicular, unleſs a ſciſſure is made in the direction *g f*, in which caſe it would be detached from the lateral preſſure, and ſo reſt upon the center. As this is not the caſe, any plea for a preſſure below C is entirely removed; and a method to determine with preciſion the actual preſſure upon the center frame is ſhewn. If the arch is the center of a circle or an ellipſe, a frame ſo much ſtronger is neceſſary, as more of the arch preſſes upon the frame; but the method of determining the ſtrength is the ſame as here laid down. A ſecond figure of the ellipſe and another calculation are required. It is here to be underſtood, that the frame calculated for is only one rib; and the weight it ſupports is that of the arch-ſtones, between the parallels C *c*, D *d*; to three feet in breadth. If, therefore, the bridge is 42 feet broad, it requires 14 ribs of the above ſtrength. Theſe are joiſted over with planks, ſuppoſe of two inches thick, and upon theſe the arch-ſtones are laid, equally carried on from C and D, and riſing equally on each ſide, till the key ſtone is ſet, in which ſtate they remain, till the engineer judges it proper to ſlacken the frame, by ſtriking out the wedges at the reſts, A and B, (or as the French uſe logs between the frame and arch), ſo far as to allow the arch-ſtones to preſs upon one another, by the equilibrated curvature of the arch; after which, it being found, that the arch is perfectly juſt and ſecure, the frame is entirely removed. In the frame, fig. 2. the tie beams are not taken into the account for ſtrength, the arch being abundantly ſtrong without them. Their uſe is merely to ſtiffen the frame, on account of the manner in which the weight is laid on. In an elliptic arch, it has been mentioned that it is ſomewhat different, requiring more ſtrength and the binding likewiſe different. In what are termed elliptic arches, few or none are ſtrictly ſo, the true elliptic curve being difficult to form on ſo large a ſcale. It may therefore be acceptable to our readers, and alſo to the ingenious mechanic, if we give the form of an ellipſe that will anſwer nearly to the elliptic equation, and upon an univerſal plan, eaſy of conſtruction. The greater and leſſer axes of the ellipſe being given, divide the exceſs of the greater axis above the leſſer into three equal parts: ſet off two of theſe from the center of the greater axis each way; upon this diſtance deſcribe an equilateral triangle on each ſide of the greater axis, and produce the ſides of the triangle both ways from the vertex of theſe triangles, to the extremity of the leſſer axis: deſcribe two arches till terminated by the ſides of the triangle produced gives the flat part of the ellipſe. At the interſection of the produced ſides of the triangle as a center, with the diſtance of the extremity of the greater axis, deſcribe an arch which will meet the other arch, and complete the ellipſe. Let AB, fig. 3. be the greater axis 60, and DE the leſſer axis 40, be drawn at right angles, biſecting one another in C. Set off AF 40, upon AB, then the exceſs FB is 20, which divide into three parts; ſet off two of theſe from C to G and H; upon GH deſcribe the equilateral triangles GHK, GHL; produce KG, KH, to any indefinite length, which may be cut by the arch drawn through D and E; from the centers KL at the interſections GH, and diſtance AB, let the other part of the ellipſe be deſcribed; thus an univerſal method of deſcribing a beautiful ellipſe, and ſo juſt that it anſwers the elliptic equation exceedingly near, at leaſt till it becomes very flat.

A ſecond form of a center frame deſcribed by Pitot, is adapted to an elliptical arch. The conſtruction differs nothing from the former, only the two upper ſtruts are parallel; the ſtrength as in the former is ſuperabundant, which is eaſily accounted for, from not knowing the real weight that lies upon the frame, or by conſidering the whole weight of the arch to reſt upon the frame. Both this and the former, Pitot has conſidered as diviſible into three pieces, which renders it more manageable in erecting, particularly in large ſpans. See fig. 4.

Fontana has given a deſcription of a very neat frame conſiſting of two pieces, the upper and the lower. The ſtruts 1 2, 1 2 taken from fig. 4 leave a repreſentation of Fontana's frame. Different conſtructions being laid before our readers, the ingenious artiſt may improve the hints that have been thrown out; and thus form a more ſimple, or better conſtruction.

We ſhall now ſelect draughts of the moſt approved center frames that we are able to collect; and make ſuch remarks upon them as may occur. Fig. 5. exhibits a form, which the experienced engineer will readily allow to be neat and ingenious; but there is much more wood and work expended than is neceſſary. It is divided into two parts, the baſe or ſtretcher LL, of the upper part, reſting upon the lower part of the frame, the greateſt part of which at leaſt muſt appear quite ſuperfluous. The lower reſts, EF, appear only neceſſary to prevent the ſtretcher LL from yielding, and thereby allowing the arch to loſe its true curvature.

The general maxim of conſtruction adopted by Perronet, a celebrated French architect, is to make the truſs conſiſt of ſeveral courſes of ſeparate truſſes, independent, as he ſuppoſes, of each other, and thus to employ the united ſupport of them all. Each truſs ſpans over the whole diſtance of the piers. It conſiſts of a number of ſtruts, ſet end to end, ſo as to form a polygon. By this conſtruction, the angles of the ultimate truſs lie in lines pointing towards the center of the curve. It is the invention of Perrault, a phyſician and architect, and was practiſed by Mandſard de Sagonne at the great bridge of Moulins.

In the centering of the bridge of Cravant, fig. 6. the arches are elliptic. The longer axis or ſpan is 60 feet, the ſemitranſverſe axis or riſe 20 feet. The arch-ſtones weigh 176lb. per foot, and are four feet in length, which is the thickneſs of the arch. The truſs beams were from 15 to 18 feet long, and 9 inches deep by 8 broad. The whole frame was conſtructed of oak. The diſtance between the truſſes, which were five in number, $5\frac{1}{2}$ feet. The whole weight of the arch amounted to 1350,000lb. which is nearly equal to 600 tons, making 112 tons for the weight on each truſs. Ninety tons of this muſt be allowed really to preſs the truſs; but a great part of the preſſure is ſuſtained by the four beams which make the feet of the truſs, joined in pairs on each ſide. The diagonal of the parallelogram of forces drawn for theſe beams is to one of the ſides as 360 to 285. Then $360:285::90:17\frac{1}{4}$ tons the weight on each foot. The ſection of each is 144 inches. Three tons may be laid with perfect ſafety on every inch; and the amount of this is 432 tons, which is ſix times more than the real preſſure on the foot-beams in their longitudinal direction. The abſolute ſtrength of each foot-beam is equal to 216 tons. But being more advantageouſly placed, the diagonal of the parallelogram of forces which correſponds to its poſition is to the ſide as 438 to 285. This is equal to $58\frac{6}{10}$ tons for the ſtrain on each foot; which is not much above one-fourth of the preſſure it is able to bear. This kind of centering, therefore, undoubtedly poſſeſſes the advantage of ſuperabundant ſtrength. The upper row of ſtruts is quite ſufficient; nothing is wanted but to procure ſtiffneſs for it.

In his executing the bridge at Neuilly, fig. 7. of 120 feet ſpan, and only 30 feet riſe; the arch 5 feet thick; his ſtrut beams are 17 by 14 inches of ſize, and king poſt 15 by nine, the ſtrut-beams placed in three parallel polygons, each abutting upon the king-poſt, he uſes the binders or bridges of 9 inches ſquare. This arch is remarkable for its flatneſs. The account Perronet gives of his ſucceſs with this frame, and the effects it produced in his work, are as follows. Notwithſtanding the different improvements he had made upon his center frame, he here found that it ſunk 13 inches, before the key-ſtones were ſet, and that the crown roſe and ſunk as the different courſes were laid. At 20 courſes on each ſide, with a load of 16 tons upon the crown, it ſunk an inch; when 20 more courſes were laid, it ſunk half an inch more, and continued ſinking as the work advanced. When the key-ſtone was ſet, it had ſunk 13 inches; and, as it ſunk at the crown, and in the advance to the crown, it roſe at the haunches, ſo as to open the upper parts of the joints almoſt an inch; which gradually leſſened towards the crown, and of conſequence the joints in the lower part opened as the upper part was compreſſed. This no doubt ſhowed a ſuppleneſs in the frame, and at the ſame time inattention in the architect, to load the crown when he perceived it ſinking, with having already too much weight upon it. If he had obſerved the crown to riſe, it would then have been proper to give it additional weight.

Let us now attend to the deſcription of the center frame of the bridge of Orleans, fig. 8. The architect to this bridge was Hupeau; and it is univerſally allowed to be an elegant ſtructure. The arch-ſtones are ſix feet in length, the form is elliptical, the ſpan 100 feet, and riſe 30. Hupeau died before any of the arches were complete. The center-frame had been placed, and ſome rows of the arch laid. Upon his demiſe, Perronet ſucceeded as architect, and finiſhed the bridge. As the work advanced, he found that the crown of the center roſe; he then found it ſink as remarkably, which ſhowed that there was ſome defect: he inſerted the long beam AB, on each ſide; he then found the frame ſufficiently ſtiff; for this made a change in the nature of the ſtrut.

Having taken a view of the practice of the French architects, as to their form and effects, let us direct our attention to thoſe of our own country, which are well worthy of notice. We ſhall only name ſome that have uſed truſſings, and among theſe we find the center-frame of Blackfriars bridge, fig. 9. The ſpan here is 100 feet; the form is elliptical, the arch-ſtones from the haunches ſeven feet, near the key-ſtone not quite ſo much, as they decreaſe in length from the haunch to the key ſtone.

A particular deſcription of this arch is not neceſſary; a view of the figure will ſhow the uſe of the different parts; it may be ſufficient to obſerve, that when the arch-ſtone was placed, it had changed its ſhape only one inch, and when the frame was taken out, the arch remained firm without any ſinking of conſequence. The great arch did not ſink above one inch, and none of them above an inch and a half; whereas thoſe already mentioned ſunk by the ſuppleneſs of the frame 13 inches, and ſome of them 9 inches more when the frame was removed.

Different methods are employed for eaſing the frame, or diſengaging it from its weight. We ſhall give a ſhort deſcription of Mr Mylne's method of placing and diſengaging his center frame from the maſon-work. Each end of the truſs was mortiſed into a plank of oak cut in the lower part as in the figure; a ſimilar piece of oak was placed to receive the upper part of the poſts. The blocks reſted upon theſe poſts, but were not mortiſed into them, pieces of wood being interpoſed. The upper part of this block was cut ſimilar to the lower part of the other; the wedge E, being intended to be driven betwixt them, was notched as in the figure, and filled up with ſmall pieces of wood, to prevent the wedge from ſliding back by the weight of the arch; which, it will appear from the figure, would have been the caſe: the event proved the fact. When the center was to he ſtruck, the inſerted pieces of wood were taken out, and the wedge, which was prepared for driving back by being girt with a ferule round the top, was removed by a piece of iron driven in with the head ſo broad as to cover the whole of the wood. A plank of wood was prepared armed with iron in the ſame manner at the one end, and ſuſpended ſo that it could freely act in driving back the wedge to any diſtance, however ſmall, with certainty. Thus, by an equal gradation, the centre was eaſed from the arch, which appeared to have been ſo equally ſupported throughout the whole of the operation, and the arch-ſtones ſo properly laid, that it did not ſink above one inch; and thus it was evident that the center might be entirely removed, having completely anſwered the purpoſe.

The above examples may be conſidered as ſufficient to ſhow the effects of the truſſed arches, which have been employed by the French architects. We ſhall now take the liberty of ſuggeſting ſome hints which may tend to improve the conſtruction, and remedy the faults and failures that have occurred in practice.

Truſſed arches for center frames being found expedient in navigable rivers, and almoſt in every river which is apt to be raiſed by rains, or other riſe in the river, the frame is apt to be endangered or carried off, to the great riſk of bringing down the arch, and ruining the work before it is finiſhed. In arches where there is no ſuch danger, the frame may be properly ſecured by poſts from below, which are made to abutt upon theſe parts of the arch where the greateſt ſtrain muſt fall.

In the center uſed by Pitot we have only to complain of an unneceſſary expenditure of wood and workmanſhip. We have already ſhown what ſtrength of oak is neceſſary, and have reduced that ſtrength of oak to an equal ſtrength of fir-wood for the ring of his frame, which alone ought to have the ſtrength required to be fully adequate to the load; but as this weight muſt be gradually applied, the frame muſt likewiſe have ſuch a degree of firmneſs as to form the exact mould of the arch that is intended. And, for this purpoſe, it muſt be prevented from yielding in any part of its arch. Now, as it has been made to appear, that the frame ſupports no part of the arch till it riſe from the ſpring to about 35 degrees, if a ſemicircle, and ſo in proportion for a ſegment of a circle; in an ellipſe, to a part ſimilar according to the nature of that curve; the ſupporting ſtruts and ties can be more particularly directed to ſupport that part of the arch which produces the greater ſtrain upon the center. In fig. 2. where the neceſſary ſtrength for Pitot's arch is pointed out, the frame of fir requiſite to ſtiffen the frame, is $9\frac{1}{2}$ by $2\frac{1}{4}$. The tie-beam C*c* is joined to thoſe parts of the arch, where the ſtrain being greateſt, would tend moſt to raiſe it in the crown. The ſtrength of this tie-beam being $9\frac{1}{2}$ by 2,, and its length 25 feet, would require a weight of 30495 lb. to make the tranſverſe fracture; one-third of this at the bridle 1, 3, is ſufficient to reſiſt the ſtrain at that part of the arch: and the abutment, being according to the principles laid down under the article Bridge, prevents the poſſibility of its riſing at the haunches; but if not formed according to theſe principles, the two tie-beams *C c D d* are joined by a third tie-beam 2, 2 with its bridle 3, 4. Fig. 4. is Pitot's centering for his elliptic arch: the ſtrength of fig. 2. may ſuffice to this by giving the ring and tie beams ½ an inch more depth.

Fig. 6. repreſents two centerings uſed by Perronet; A is that uſed by him in erecting the bridge at Nogent, and B that at Maxence; they differ little from one another. That at Nogent is 90 feet by 28 of height. The ſpan of the latter being greater, we ſhall here conſider the weight to be ſupported. This is the arch from A to C, which is an arch of 47° 45′. The meaſurement is 42 feet; the arch-ſtones 4½, and ſuppoſing them 3 feet broad, they would amount to 567.9 ſolid feet, which, at 160lb. per foot, is equal to 90866.88lb. This is little more than one-half of the ſemicircular arch; and, although it is flatter, the weight is ſo much leſs, that no additional ſtrength is neceſſary to be given to the frame, fig. 2. for the 60 feet ſpan. There is likewiſe abundance of ſtrength of materials for the 90 feet arch; but on the greater extent, that it may be rendered more ſtiff, a tie-beam 1, 4, 3, 4 may be added on each ſide of the arch, as repreſented by the dotted line.

It is ſcarcely neceſſary to make any farther calculations on the centering uſed by Perronet. It appears, that notwithſtanding the ſuperabundance of wood employed, they were ſo ſupple as when uſed upon an extended arch, they roſe and ſunk ſo much, that the arch was changed from its intended form by a radius of ſeveral feet. Theſe changes took place in erecting the bridges at Nogent and Maxence, which are repreſented in fig. 6. Perronet, it would appear, was not ſatiſfied with theſe; and, convinced of their inſufficiency, changed the form of the frame of the bridge at Neuilly. But this form is far from anſwering the purpoſe; for, when the arch-ſtones began to preſs upon the centering, it yielded to the weight. He then loaded the crown to prevent its riſing there, but it ſtill ſunk; he added more weight to the crown, it continued ſinking as the work advanced. When the key-ſtone was ſet, it had ſunk more than 13 inches, and it was found to have raiſed the haunches; for when the centering was ſlackened, the arch ſtill ſunk for about 9 inches more. The arch-ſtones being raiſed at the haunches, the joints were of neceſſity opened; for the preſſure from the crown, when the centering was removed, forced them again into contact, by which the arch flattened to ſuch a degree, that from an arch intended to have a radius of 150 feet, it flattened till part of it was as if formed from a radius of 244 feet. It here appeared to be ſettled, from which a conſiderable deformity muſt appear in the ſtructure; which deformity took its riſe from two evident cauſes: the want of firmneſs in the centering, and the bridge not properly loaded at the haunches. It is evident, that if the load at the haunches is only equal to the weight of the arch-ſtones from the place where they begin to reſt on the centering to the crown of the arch, the preſſure of the arch could never overcome itſelf or its equal weight upon the haunches; much more, if the weight upon the haunches, before it comes to preſs upon the centering, was made to exceed that part of the arch that did preſs upon it, the load upon the crown of the arch would have reſtored the figure of the centering. It ſeems to be a ſtrange overſight, that Perronet, when he ſaw that his centering was riſing at the haunches, did not apply his loading to this part of the arch, by which he might have reſtored it to its equilibrium before his center was ſtruck, and before his lime had loſt the band; if this is once done, it is allowed that it does not again recover it.

From the whole of this it appears evident, that filling up the haunches to a proper height, ſo as to make a firm abutment to the preſſing part of the arch, ſerves two good purpoſes. It acts as an abutment to the center frame, in preventing its ſinking by the load as the work advances; and likewiſe prevents the arch-ſtones at the haunches being raiſed from their beds; for it is only acted upon by a force conſiderably leſs than what they have a power to reſiſt. Having now ſeen the defects of this centering, and animadverted on the manner of executing the work, let us now examine the weight of this arch, and what reſiſtance would have prevented its change in ſhape, and preſerved its intended form.

The part of the arch that preſſes upon the center, is from C to C, fig. 10. an arch of 36 degrees, and meaſures 94⅓ feet nearly; the ſtones 5 feet in length, and breadth 3, make 1979.035 ſolid feet, ×160lb. the weight of a ſolid foot, make the whole weight 316645.88lb. Allow each beam of the truſs to be 7 feet, and its abſolute ſtrength, to tear it at 12 inches deep, by one inch thick, 189163; the abſolute power of tranſverſe fracture, 95416lb. The ſtrength of the arch is the mean of theſe, or ratio compounded; taking one-third of each, the geometrical mean is 44285 lb. that each 7 feet can ſuſtain when formed into an arch; there are 13 times 7 in 94 feet, equal to a power of 582764, to ſuſtain the weight of 316645.68 if equally diſtributed. But this not being the caſe, a tie-beam of about 30 feet marked *c c*, *d d*, will prevent the arch yielding to the preſſure. It is ſupported at *e* by the ſtruts *E e*, *h h*; and theſe by the joint ſupport of *e f*, *h f* tied at *k*. The whole center frame is ſupported by the upright poſts CC, DD. Two wedges A and B are placed acroſs between two blocks which are fitted for a reſt to the frame. When it is required to be ſlackened, and the frame withdrawn from the arch, they allow it to reſt by its own preſſure. This, it muſt appear obvious, ought to be done when the key-ſtone is ſet before the lime has begun to be dry and ſolid.

The center frame of the bridge of Orleans is repreſented fig. 8. It has been already noticed in this undertaking, that Perronet ſucceeded Hupeau. As the work advanced, he found the arch and frame to ſink, and trying his ordinary mode of loading the crown of the arch, he was now taught by experience to ſtrengthen his center frame, and happily ſucceeded by continuing his ſtrut. By forming the baſe of the triangle 1, 2, 3, on each ſide, his frame was rendered ſufficiently ſtiff, and the inner part below AB, AB became ſuperfluous. The weight that preſſes upon this frame is great, both on account of the flatneſs of the arch, and the length of the arch-ſtone. The preſſing arch is an arch of 57 degrees; it meaſures 88.87 feet, × 6 the length of the arch ſtone, and by 3 in width, makes 1599.66 ſolid feet × 160lb. the weight of a ſolid foot, gives 255945.6lb. The length of each plank of the truſs being 7 feet, depth 12 inches by 2 inches thick, the ſtrength is 189163lb. The weight for every 7 feet in length of the arch, one-third of this 63054$\frac{1}{3}$lb. in 88 feet, there is 12 times 7, that is 63054 3 × 12=756,652lb. to ſupport 255945.6lb. more than 3 times ſtronger, without taking into account the ſtrength of the arch, being the mean of the ſplitting force and tranſverſe ſection: the tie-beams, as in fig. 7. will be of abundant ſtrength to ſtiffen the frame.

The next we take notice of is, the truſs frame, fig. 9. uſed by Mr Mylne, at Blackfriars bridge, London. This is ſupported by ties and ſtruts in ſuch a manner, that no ſinking took place during the maſon work going on, although the arch-ſtones at the haunches were 7 feet, gradually leſſening to the crown of the arch; and, when the frame was ſtruck, which was done by a very ingenious method, by the wedges of the conſtruction, as in the figure, in place of ſinking 9 inches, it did not ſink above 1, which may well be accounted for by the compreſſion of the mortar; whether a ſmaller quantity of materials might not have anſwered the ſame purpoſe, ſuch as fig. 7. we ſhall refer to the judicious reader, or to the ingenious artiſt who may have occaſion to depend upon ſuch frames for ſupport of this work, or a tie beam between 1 and 3 on each ſide, repreſented by the dotted line. As there is a ſtrain upon the frame at *s*, *s*, let theſe tie-beams be ſupported by the ſtruts *a* 3, *b* 3 on each ſide, and tied at 4, 4 as repreſented by the dotted line 4, 4. It does not appear that what lies between the dotted line *a* 4, 4 *b* bears any part in the ſupport or ſtiffneſs of the frame, and therefore becomes unneceſſary; nor does it appear, that the different beams uſed as king-poſts are of ſo much advantage for ſtrengthening the frame, as tie-beams would be. At the ſame time, thoſe uſed by Mr Mylne are employed with ſo much judgement, that none of their effects are miſapplied. This cannot be ſaid of any of the frames uſed by the French architects, even of that uſed at the bridge of Orleans. They are not often employed by the Britiſh architects; they rather prefer a tie-beam at the ſpring of the arch from one ſide to the other. This, however, might be as judiciouſly applied at the height where the arch begins to reſt upon the frame, eſpecially if the ſhoulders are properly loaded or filled up, ſo as to be a counterpoiſe to the arch-ſtones, that reſt upon the frame. In this caſe they effectually prevent the neceſſity of a tie-beam, as a diameter at the ſpring of the arch; and from the ſpring proper ſupports may be given at the upper tie-beam, and from it to any part of the arch, where the greateſt ſtrain lies.

Having from the examples adduced, and the obſervations made upon them, found center-frames of ſufficient ſtrength to ſupport arches of very extenſive ſpans, and even greater extent than they have yet been applied; it may be ſaid, why not continue theſe frames for the bridge, without the very great additional expence of throwing a ſtone arch over them? The maſon would anſwer, that the ſtone was more durable, and had other advantages, particularly as to neatneſs, when once thrown, and freed from the uncouth truſſes and tie-beams neceſſary in the wooden frame. The carpenter would reply, that if wood was not ſo durable as ſtone, it could be raiſed at much leſs expence; and, when it failed in any part, it could be replaced at a ſmall expence, and made to laſt longer than a ſtone arch; which latter, when it fails, requires as much expence as at firſt, and even more, in clearing off the rubbiſh of its decayed and now uſeleſs materials. As to neatneſs, the frame of wood vies with the arch of ſtone in elegance, and is erected at half the expence, and even leſs. But now ſince iron materials are introduced in place of ſtone, there is room for experiments with regard to neatneſs and extent of ſpan.

We ſhall here ſuppoſe the carpenter exhibits this plan. Let AB be a ſpan of 60 feet, (fig. 11.) the arch a ſemicircle, the abſolute ſtrength of oak a plank 12 inches by one is 189163 lb. Let the arch be compoſed of pieces 5 feet long, 12 inches deep, and 2 inches broad; a ſecond arch joining to this, of the ſame depth and breadth in cloſe contact, but the joints of the one to the middle of the other, like brick-building, or as the carpenters expreſs it breaking joint. The abſolute ſtrength of this arch is, before the two truſſes are joined, more than 84 ton, as may be collected from the calculations above, which is more than 3 times what can ever come upon it. The beauty of this arch would be hurt by placing ſtruts below to ſtiffen it, for which there is not the ſmalleſt occaſion; for it can be ſtiffened to better advantage above the arch. But this is not practicable in center-frames. Let the road-way be CDEF, reſting upon the perpendicular ſupport 1, 2, 3, &c. As the carriage acts upon theſe in the oblique direction, tranſepts from the arch in a radial direction, give them the advantage of equal preſſure upon the arch. Each of theſe perpendiculars is mortiſed into ſhort pieces, that will form into an arch, the pieces all abutting one upon another, and forming a fillet over the arch, and projecting ſo far, that the faces of an architrave of any order may be formed along the face of the arch, which adds both to its ſtrength and beauty. Thus there is formed a rib, 12 inches deep and 4 thick, with its fillet over it 4 inches deep and ſix inches broad, to cover the faces of the architrave. Suppoſe the arch 44 feet wide, 7 of theſe ribs may give a ſtrength not inferior to the ſtrength of ſtone or any metal; but it will be ſaid, it will not be ſo durable. It is well known how long wood laſts in the roofs, and joiſts of flooring, and even when it forms a part of the wall of a houſe built of brick. The interſtices between theſe perpendicular bearings of the wood may be built up with brick; even brick on edge, or brick thick, will render its preſervation equal to what it is in a houſe, and will preſerve it from the bad effects of wet and dry; and the lower part of the ribs covered with a thin lining. A door being left in the ſide to obſerve at different times any failure in the wood, it may be repaired without interrupting the paſſage by the bridge. It ought to be ſo covered above, that water may be prevented from going through to the injury of the bridge. It has been formerly mentioned, in ſpeaking of the proportional ſtrength of oak and fir, and by the calculation it appeared, that fir plank 13½ inches, is equal in ſtrength to oak of 12 inches. And thus a framing of wood does not much exceed the expence of centering either a ſtone or iron bridge; and is not inferior even in elegance.

The ſpan here propoſed is only 60 feet. But an arch of 600 feet may be required, which muſt have a centering to ſupport the weight and preſerve the figure; the ſize of that center frame can be made of ſtrength equal, and even to exceed the weight it has to ſupport. It can be rendered ſtiff by the method propoſed for the 60 feet arch. This, therefore, will be a bridge that will ſupport any weight that can be laid upon it, and may be of any figure, elliptical, or at the pleaſure of the architect, any other curve which may be required. It may be framed in a ſimilar manner to thoſe formed of iron, but it is natural to ſuppoſe that one arch over the other will be equally ſtrong and more eaſily preſerved from the weather, conſtructed in the way deſcribed above.

In the ſimple wooden bridges not curved, it is only neceſſary to refer to fig. 7. where the ſtruts E *c*, *f*, *h g*, will be a ſupport for planks, that will form a ſtraight bridge, joining ſo many ribs as are neceſſary for the bridge according to its breadth.

The joints may be ſecured from opening by dovetailed pieces being inſerted acroſs the joints on the inſide of the rib; the abutments prevent the ends of the arch from flying out. The preſſure above coming upon it obliquely, may be ſaid to tend to make it riſe at the crown, eſpecially when of a great ſpan. In the center-frame, the only manner of preventing this is by ſtruts and tie-beams judiciouſly applied. Here the riſe may be prevented more effectually without hurting the ornamental part of the arch. In the abutment, which muſt be of maſon-work, let a beam be built into the wall, the ends at G and K projecting 1 foot, correſponding to each rib, the road-way formed by the beam DE; let a tie-beam GD, KE, join theſe in the manner the carpenter knows to be the moſt ſecure; from this tie-beam, let the radial ſtruts be mortiſed into the fillets at G, K, formerly deſcribed, inſtead of the perpendiculars there named, and perpendiculars joining the road-way CDEF, and reſting on the tie-beam GD, KE, ſupported by the radial ſtruts 4, 5, 6, as in the figure. Thus the crown of the arch cannot riſe without lifting up the whole body of the abutment at each end, and it cannot ſink till the weight laid upon it is ſufficient to cruſh the materials of which the arch is compoſed. In this manner a neat and elegant arch is procured, that may at a ſmall comparative expence be kept up for centuries Here is then a choice of three ſpecies of arches, that may vie with each other in point of ſtrength. With the laſt none may compare in point of elegance, and in duration, perhaps not inferior to the iron bridge.

Center *of Gravity*, in *Mechanics*, that point about which all the parts of a body do in any ſituation exactly balance each other.

Center *of Motion*, that point which remains at reſt, while all the other parts of a body move about it.

Center *of Sphere*, a point in the middle, from which all lines drawn to the ſurface are equal, Hermis Triſmegiſtus defines God an intellectual ſphere, whoſe center is everywhere, and circumference nowhere.

CENTESIMA usura, that wherein the intereſt in a hundred months became equal to the principal, i. e. where the money is laid out at one per cent. per month; anſwering to what in our ſtyle would be called 12 per cent. for the Romans reckoned their intereſt not by the year, but by the month.

CENTESIMATION, a milder kind of military puniſhment in caſes of deſertion, mutiny, and the like, when only every hundredth man is executed.

CENTILOQUIUM, denotes a collection of 100 ſentences, opinions, or ſayings.

The centiloquium of Hermes contains 100 aphoriſms, or aſtrological ſentences, ſuppoſed to have been written by ſome Arab, falſely fathered on Hermes Triſmegiſtus. It is only extant in Latin, in which it has ſeveral times been printed.—The centiloquium of Ptolemy is a famous aſtrological piece, frequently confounded with the former, conſiſting likewiſe of 100 ſentences or doctrines, divided into ſhort aphoriſms, entitled alſo in Greek καρπος, as being the fruit or reſult of the former writings of that celebrated aſtronomer, viz. his *quadripartitum* and *almageſtum*; or rather, by reaſon that herein is ſhown the uſe of aſtrological calculations.

CENTIPES, in *Zoology*. See Scolopendra.

CENTIPED worm, a term uſed for ſuch worms as have a geeat many feet, though the number does not amount to 100, as the term ſeems to import.—M. Malouet relates the hiſtory of a man, who, for three years, had a violent pain in the lower part of the forehead near the root of the noſe; at length he felt an itching, and afterwards ſomething moving within his noſtril, which he brought away with his finger; it was a worm of the centiped kind, an inch and a half long, which run ſwiftly. It lived five or ſix days among tobacco. The patient was free of his pain ever after. Mr Littre mentioned a like caſe in 1708, of a larger centiped voided at the noſe, after it had thrown the woman, in whoſe frontal ſinus it was, into convulſions, and had almoſt deprived her of her reaſon.

CENTLIVRE, Susanna, a celebrated comic writer, was the daughter of Mr Freeman of Holbeach, in Lincolnſhire; and had ſuch an early turn for poetry, that it is ſaid ſhe wrote a ſong before ſhe was ſeven years old. Before ſhe was twelve years of age, ſhe could not only read Moliere in French, but enter into the ſpirit of all the characters. Her father dying, left her to the care of a ſtep-mother, whoſe treatment not being agreeable to her, ſhe determined, though almoſt deſtitute of money and every other neceſſary, to go up to London to ſeek a better fortune than what ſhe had hitherto experienced. As ſhe was proceeding on her journey on foot, ſhe was met by a young gentleman from the univerſity of Cambridge, the afterwards well-known Anthony Hammond, Eſq. who was ſo extremely ſtruck with her youth and beauty, that he fell inſtantly in love with her; and inquiring into the particulars of her ſtory, ſoon prevailed upon her unexperienced innocence to ſeize on the protection he offered her, and go with him to Cambridge. After ſome

Fig. 1.

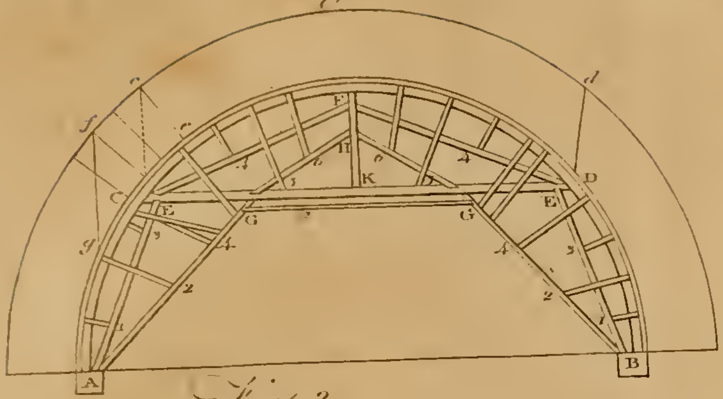
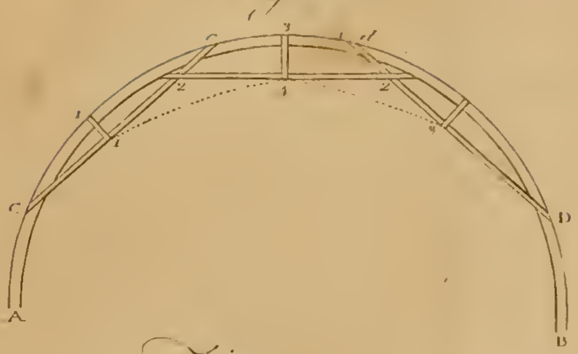


Fig. 2



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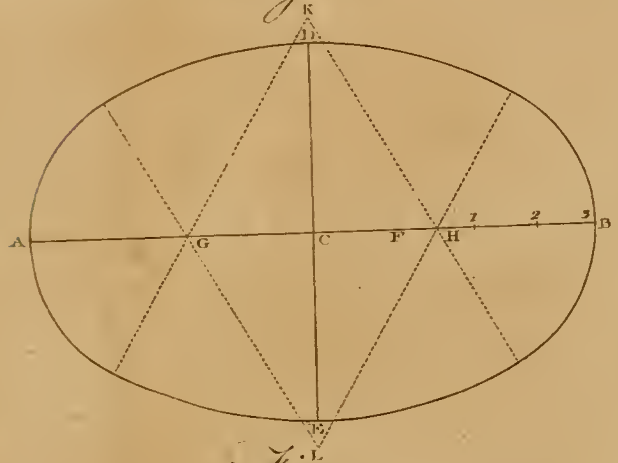

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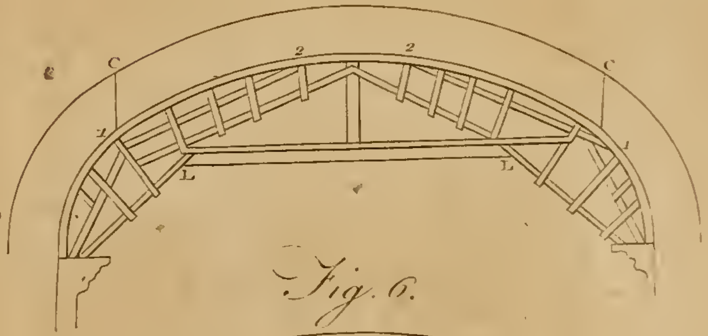


Fig. 6.

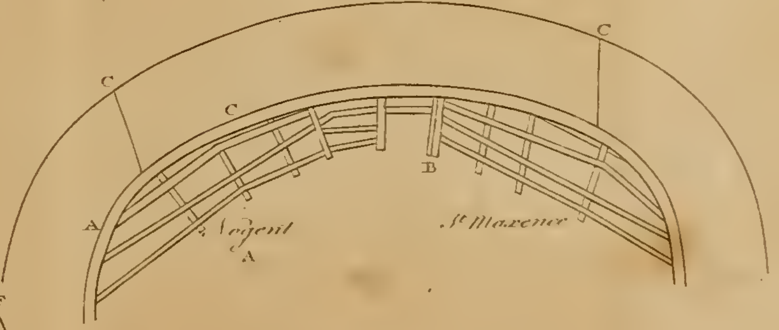


Fig. 5.

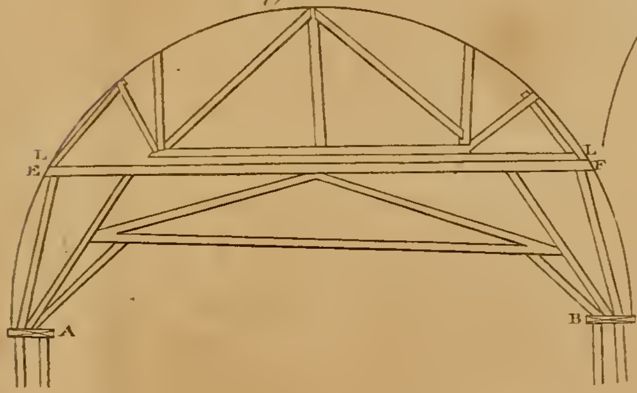
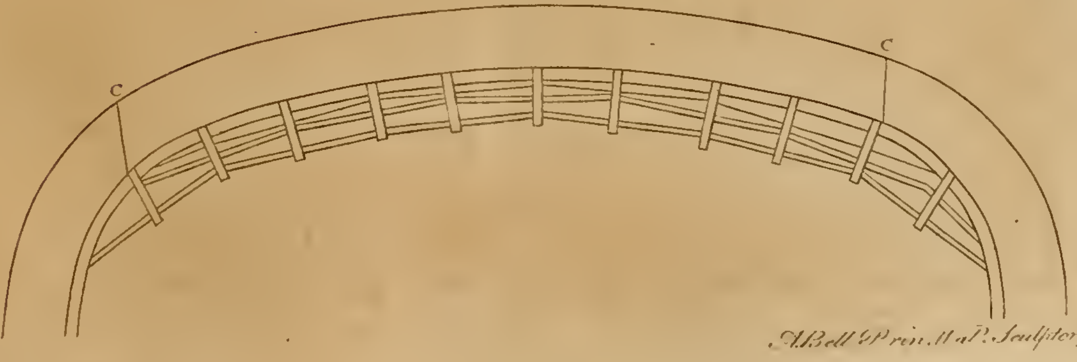


Fig. 7.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 8.

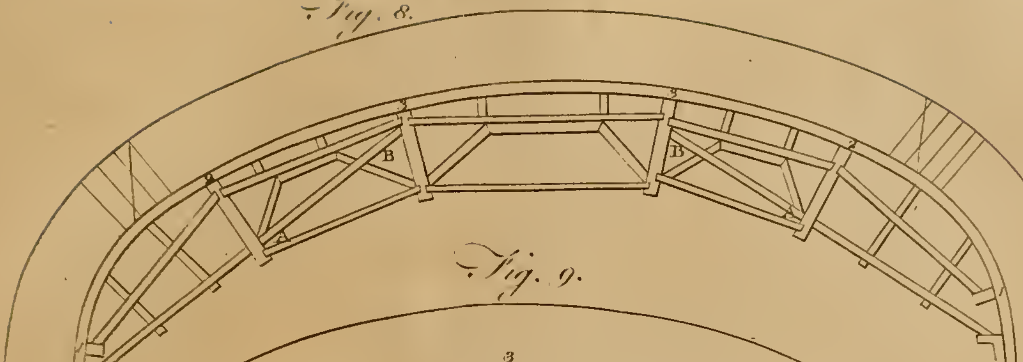


Fig. 9.

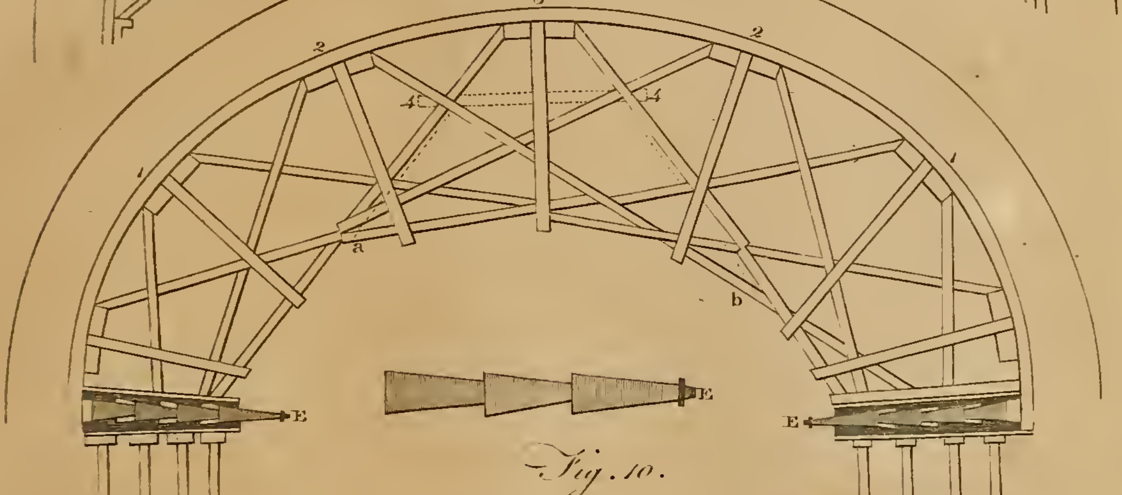


Fig. 10.

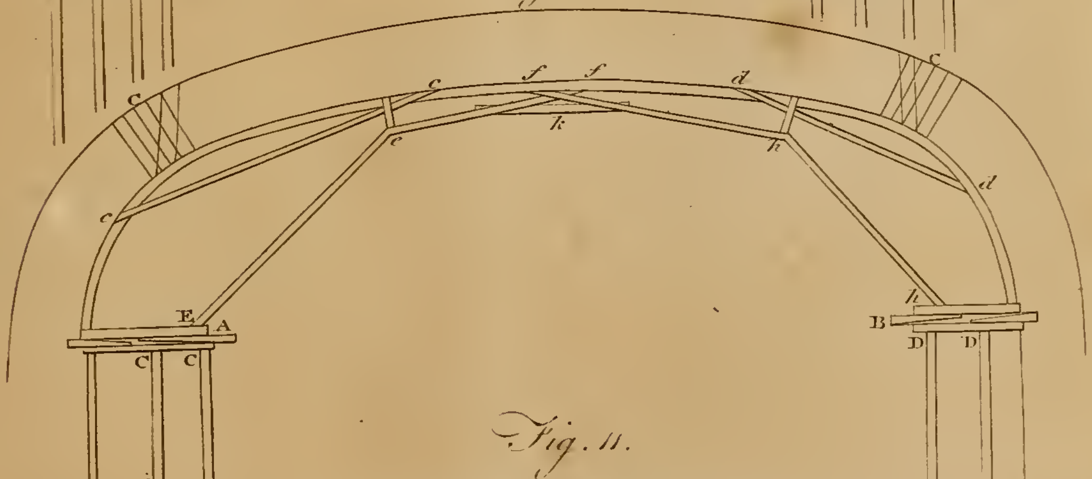
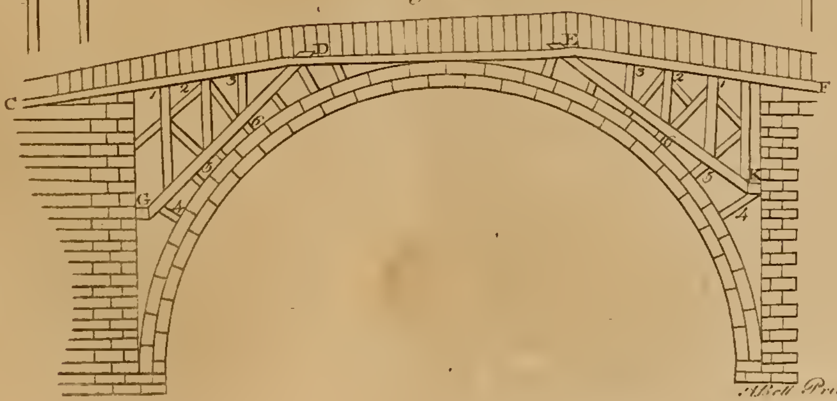


Fig. 11.



A. Bell Prin. Wal. Sculptor

ſome months cohabitation, he perſuaded her to come to London, where, in a ſhort time, ſhe was married to a nephew of Sir Stephen Fox. But that gentleman not living with her above a twelvemonth, her wit and beauty ſoon procured her a ſecond huſband, whoſe name was Carrol, and who was an officer in the army; but he having the misfortune to be killed in a duel about a year and a half after their marriage, ſhe became a ſecond time a widow. For the ſake of ſupport ſhe now applied to her pen, and became a votary of the muſes; and it is under this name of Carrol that ſome of her earlier pieces were publiſhed. Her firſt attempt was in tragedy, in a play called the *Perjured Huſband;* yet natural vivacity leading her afterwards to comedy, we find but one more attempt in the buſkin, among 18 dramatic pieces which ſhe afterwards wrote.

In 1706, ſhe wounded the heart of one Mr Joſeph Centlivre, yeoman of the mouth, or, in other words, principal cook to her majeſty, who married her; and, after paſſing ſeveral years happily together, ſhe died at his houſe in Spring Garden, Charing-croſs, in December 1723.

This lady for many years enjoyed the intimacy and eſteem of the moſt eminent wits of the times, viz. Sir Richard Steele, Mr Rowe, Budgell, Farquhar, Dr Sewell, &c.; and very few authors received more tokens of eſteem and patronage from the great. With regard to her merit as a writer, it muſt be allowed that her plays do not abound with wit, and that the language of them is ſometimes even poor, enervate, incorrect, puerile; but then her plots are buſy and well conducted, and her characters in general natural and well marked.

CENTNER, or DOCIMASTIC HUNDRED, in *Metallurgy* and *Aſſaying*, is a weight diviſible, firſt into a hundred, and thence into a greater number of other ſmaller parts; but though the word is the ſame both with the aſſayers and metallurgiſts, yet it is to be underſtood as expreſſing a very different quantity in their different acceptation of it. The weights of the metallurgiſts are eaſily underſtood, as being of the common proportion; but thoſe of the aſſayers are a thouſand times ſmaller than theſe, as the portions of metals or ores examined by the aſſayers are uſually very ſmall.

The metallurgiſts, who extract metals out of their ores, uſe a weight divided into a hundred equal parts, each part a pound; the whole they call a *centner* or *hundred weight;* the pound is divided into thirty-two parts, or half ounces; and the half ounce into two quarters of ounces, and theſe each into two drachms.

Theſe diviſions and denominations of the metallurgiſts are eaſily underſtood; but the ſame words, though they are equally uſed by aſſayers, with them expreſs very different quantities; for as the centner of the metallurgiſts contains a hundred pounds, the centner of the aſſayers is really no more than one dram, to which the other parts are proportioned.

As the aſſayers weights are divided into ſuch an extreme degree of minuteneſs, and are ſo very different from all the common weights, the aſſayers uſually make them themſelves in the following manner, out of ſmall ſilver, or fine ſolder plates, of ſuch a ſize, that the mark of their weight, according to the diviſion of the dram, which is the *docimaſtic* or aſſaying *centner*, may be put upon them. They firſt take for a baſis one weight, being about two thirds of a common dram: this they mark (64lb.) Then having at hand ſome granulated lead, waſhed clean, well dried, and ſifted very fine, they put as much of it into one of the ſmall diſhes of a fine balance as will equipoiſe the (64lb.) as it is called, juſt mentioned: then dividing the granulated lead into very nice halves, in the two ſcales, after taking out the firſt ſilver weight, they obtain a perfect equilibrium between the two ſcales; they then pour the granulated lead out of one diſh of the ſcales, and inſtead of it put in another ſilver weight, which they make exactly equiponderant with the lead in the other ſcale, and mark it (32lb.) If this ſecond weight, when firſt put into the ſcale, exceed by much the weight of the lead, they take a little from it by a very fine file; but when it comes very near, they uſe only a whetſtone to wear off an extremely ſmall portion at a time. When it is brought to be perfectly even and equal to the lead, they change the ſcales to ſee that no error has been committed, and then go on in the ſame manner till they have made all the diviſions, and all the ſmall weights. Then to have an entire centner or hundred weight, they add to the (64lb) as they call it, a 32lb. and a 4lb. and weighing againſt them one ſmall weight, they make it equal to them, and mark it (100.) This is the docimaſtical, or aſſaying centner, and is really one dram.

CENTO, in poetry, a work wholly compoſed of verſes or paſſages promiſcuouſly taken from other authors, only diſpoſed in a new form and order.—Proba Falconia has written the life of Jeſus Chriſt in centos taken from Virgil. Alexander Roſs has done the like in his Chriſtiados, and Stephen de Pleure the ſame.

CENTONARII, in antiquity, certain of the Roman army, who provided different ſorts of ſtuff called *centones*, made uſe of to quench the fire which the enemy's engines threw into the camp.

Theſe centonarii kept with the carpenters and other officers of artillery.

CENTRAL FORCES, the powers which cauſe a moving body to tend towards, or recede from, the centre of motion. See MECHANICS.

CENTRAL Rule, a rule diſcovered by Mr Thomas Baker, whereby to find the centre of a circle deſigned to cut the parabola in as many points as an equation to be conſtructed hath real roots. Its principal uſe is in the conſtruction of equations, and he hath applied it with good ſucceſs as far as biquadratics,

The central rule is chiefly founded on this property of the parabola, that, if a line be inſcribed in that curve perpendicular to any diameter, a rectangle formed of the ſegments of the inſcript is equal to the rectangle of the intercepted diameter and parameter of the axis.

The central rule has the advantage over Carter and De Latere's methods of conſtructing equations, in that both theſe are ſubject to the trouble of preparing the equation by taking away the ſecond term.

CENTRIFUGAL FORCE, that force by which all bodies that move round any other body in a curve endeavour to fly off from the axis of their motion in a tangent to the periphery of the curve, and that in every part of it. See Mechanics.

Centrifugal-Machine, a very curious machine, invented by Mr Erſkine, for raiſing water by means of a centrifugal force combined with the preſſure of the atmoſphere.

It conſiſts of a large tube of copper, &c. in the form of a croſs, which is placed perpendicular in the water, and reſts at the bottom on a pivot. At the upper part of the tube is a horizontal cog-wheel, which touches the cogs of another in a vertical poſition; ſo that by the help of a double winch, the whole machine is moved round with very great velocity.

Near the bottom of the perpendicular part of the tube is a valve opening upwards; and near the two extremities, but on the contrary ſides of the arms, or croſs part of the tube, are two other valves opening outwards. Theſe two valves are, by the aſſiſtance of ſprings, kept ſhut till the machine is put in motion, when the centrifugal velocity of the water forces them open, and diſcharges itſelf into a ciſtern or reſervoir placed there for that purpoſe.

On the upper part of the arms are two holes, which are cloſed by pieces ſcrewed into the metal of the tube. Before the machine can work, theſe holes muſt be opened, and water poured in through them, till the whole tube be full: by this means all the air will be forced out of the machine, and the water ſupported in the tube by means of the valve at the bottom.

The tube being thus filled with water, and the holes cloſed by the ſcrew caps, it is turned round by means of the winch, when the water in the arms of the tube acquires a centrifugal force, opens the valves near the extremities of the arms, and flies out with a velocity nearly equal to that of the extremities of the ſaid arms.

The above deſcription will be very eaſily underſtood by the figure we have added on Plate CXXXVII. which is a perſpective view of the centrifugal machine, erected on board a ſhip. ABC is the copper tube. D, a horizontal cog-wheel, furniſhed with twelve cogs. E, a vertical cog-wheel, furniſhed with thirty-ſix cogs. F, F, the double winch. *a*, the valve near the bottom of the tube. *b*, *b*, the two pivots on which the machine turns. *c*, one of the valves in the croſs piece; the other at *d*, cannot be ſeen in this figure, being on the other ſide of the tube. *e*, *e*, the two holes through which the water is poured into the machine. GH, the ciſtern or reſervoir. I, I, part of the ſhip's deck. The diſtance between the two valves, *c*, *d*, is ſix feet. The diameter of theſe valves is about three inches; and that of the perpendicular tube about ſeven inches.

If we ſuppoſe the men who work the machine can turn the winch round in three ſeconds, the machine will move round its axis in one ſecond; and conſequently each extremity of the arms will move with a velocity of 18.8 feet in a ſecond. Therefore a column of water of three inches diameter will iſſue through each of the valves with a velocity of 18.8 feet in a ſecond: but the area of the aperture of each of the valves is 7.14 inches; which being multiplied by the velocity in inches =225.6, gives 1610.784 cubic inches, the quantity of water diſcharged through one of the apertures in one ſecond; ſo that the whole quantity diſcharged in that ſpace of time through both the apertures is =3221.568 inches; or 193294 08 cubic inches in one minute. But 60812 cubic inches make a tun beer-meaſure; conſequently, if we ſuppoſe the centrifugal machine revolves round its axis in one ſecond, it will raiſe nearly 3 tuns 44 gallons in one minute: but this velocity is certainly too great, at leaſt to be held for any conſiderable time; ſo that, when this and other deficiencies in the machine are allowed for, two tuns is nearly the quantity that can be raiſed by it in one minute.

It will perhaps be unneceſſary to obſerve, that as the water is forced up the perpendicular tube by the preſſure of the atmoſphere, this machine cannot raiſe water above 32 feet high.

An attempt was made to ſubſtitute this machine in place of the pumps commonly uſed on ſhip board; but the labour of working was found to be ſo great as to render the machine inferior to the chain-pump. A conſiderable improvement, we apprehend, would be, to load with a weight of lead the ends of the tubes through which the water iſſues, which would make the machine turn with a great deal more eaſe, as the centrifugal force of the lead would in ſome meaſure act the part of a fly.

CENTRIPETAL force, that force by which a body is everywhere impelled, or any how tends, towards ſome point as a centre. See Mechanics.

CENTRISCUS, in *Ichthyology*, a genus of fiſhes belonging to the order of amphibia nantes. See Ichthyology *Index*.

CENTRONIA, in *Natural Hiſtory*, a name by which the echini marini have been diſtinguiſhed. Dr Hill makes them a diſtinct claſs of animals living under the defence of ſhelly coverings formed of one piece, and furniſhed with a vaſt number of ſpines moveable at the creature's pleaſure.

CENTUMCELLÆ, in *Ancient Geography*, Trajan's villa in Tuſcany, on the coaſt, three miles from Algæ; with an excellent port, called *Trajanus Portus*, (Ptolemy); and a factitious iſland at the mouth of the port, made with a huge block of ſtone, on which two turrets roſe, with two entrances into the baſon or harbour, (Rutilius). Now *Civita Vecchia*. E. Long. 12. 30. N. Lat. 42°.

CENTUMVIRI, in Roman antiquity, judges appointed to decide common cauſes among the people: They were choſen three out of each tribe; and though five more than a hundred, were nevertheleſs called *centumviri*, from the round number *centum* a hundred.

CENTUNCULUS. See Botany *Index*.

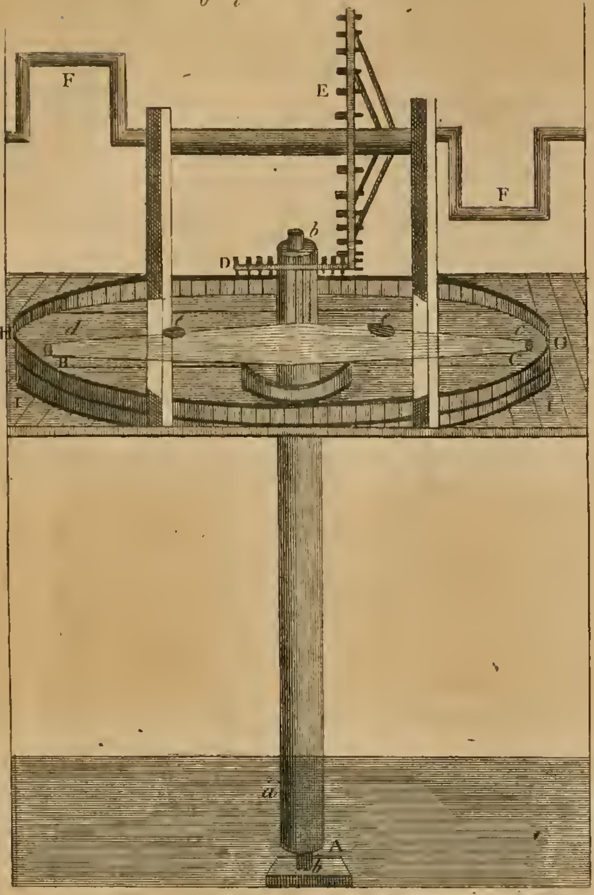
CENTURION, among the Romans, an officer in the infantry, who commanded a century, or a hundred men.

In order to have a proper notion of the centurions, it muſt be remembered, that every one of the thirty manipuli* in a legion was divided into two *ordines*, or ranks; and conſequently the three bodies of the haſtati, principes, and triarii, into 20 orders a piece, as into 10 manipuli. Now, every manipulus was allowed two centurions, or captains, one to each order or century: and, to determine the point of priority between them, they were created at two different elections. The 30 who were made firſt always took the precedency of their fellows; and therefore commanded the right-hand orders, as the others did the left. The triarii, or

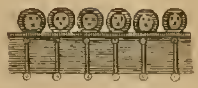
* See *Manipulus*.

Plate CXXXVII.

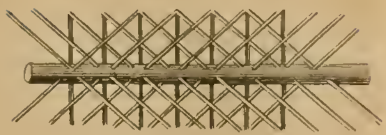
Centrifugal Machine



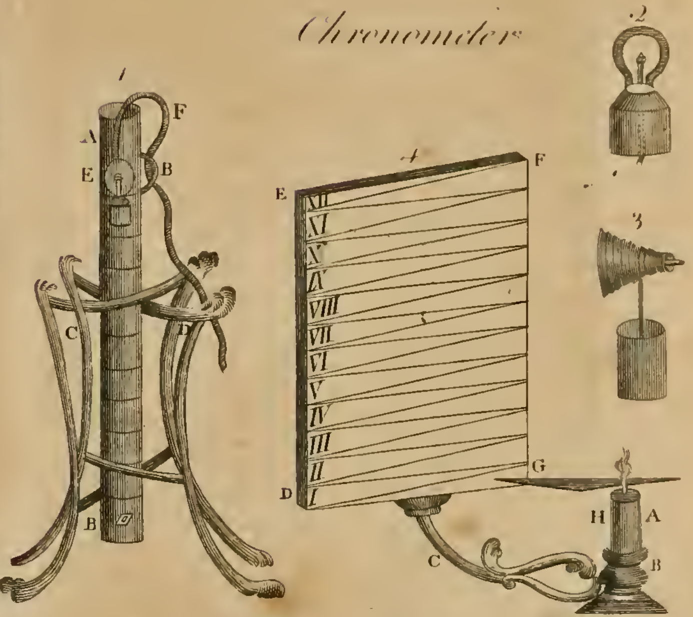
Chain wales



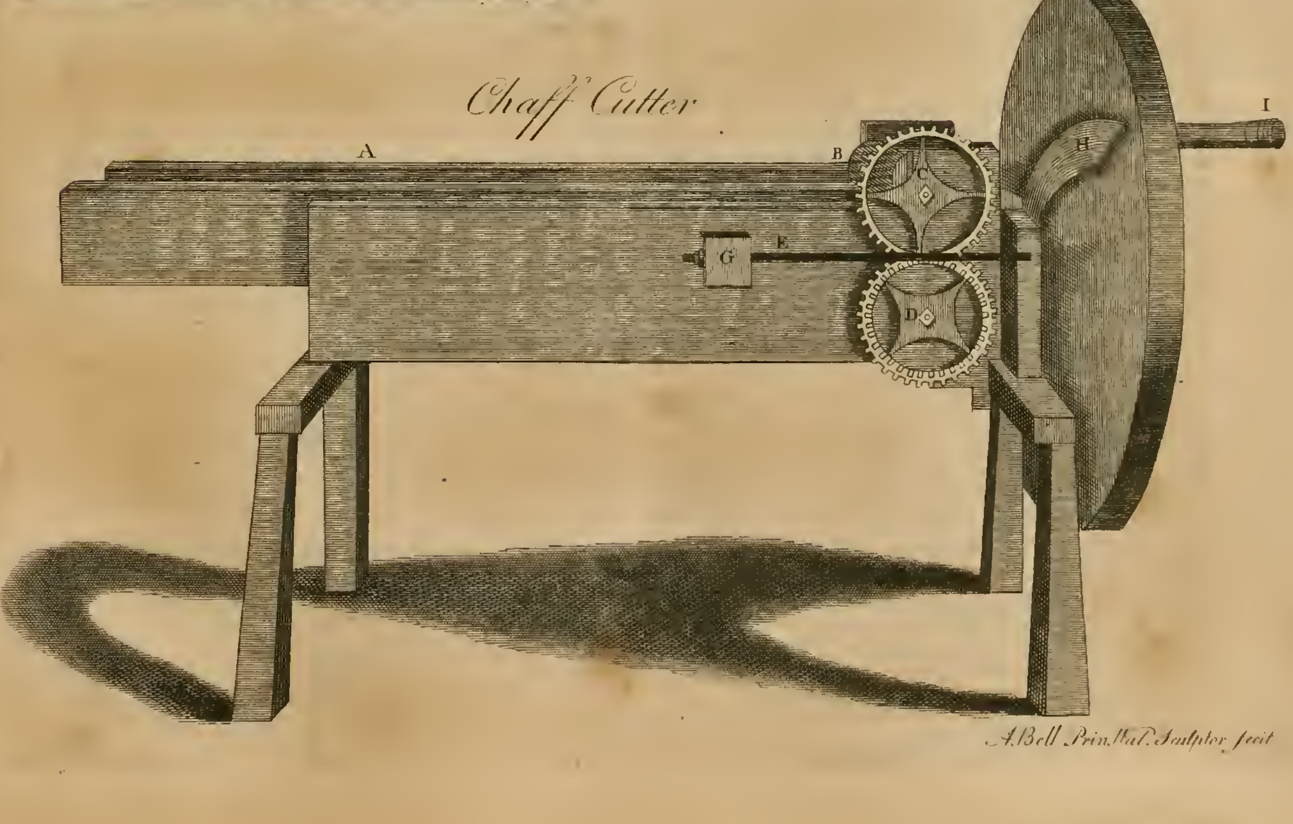
Cheval de Frise



Chronometer



Chaff Cutter



A. Bell Prin. Wal. Sculptor fecit

or *pillani*, ſo called from their weapon the *pilum*, being eſteemed the moſt honourable, had their centurions elected firſt, next to them the principes, and afterwards the haſtati; whence they were called *primus et ſecundus pilus, primus et ſecundus princeps, primus et ſecundus haſtatus*; and ſo on. Here it may be obſerved, that *primi ordines* is ſometimes uſed in hiſtorians for the centurions of theſe orders; and the centurions are ſometimes ſtyled *principes ordinum*, and *principes centurionum*. We may take notice too what a large field there lay for promotion: firſt through all the orders of the haſtati; then quite through the principes; and afterwards from the laſt order of the triarii to the primipilus, the moſt honourable of the centurions, and who deſerves to be particularly deſcribed. This officer, beſides his title of primipilus, went under the ſeveral titles of *dux legionis, præfectus legionis, primus centurionum*, and *primus centurio*; and was the firſt centurion of the triarii in every legion. He preſided over all the other centurions, and generally gave the word of command by order of the tribunes. Beſides this he had the care of the eagle or chief ſtandard of the legion: hence, *aquilæ præeſſe*, is to bear the dignity of primipilus; and hence *aquila* is taken by Pliny for the ſaid office. Nor was this ſtation only honourable, but very profitable too: for he had a ſpecial ſtipend allowed him, probably as much as a knight's eſtate; and, when he left that charge, was reputed equal to the members of the equeſtrian order, bearing the title of *primipilarius*, in the ſame manner as thoſe who had diſcharged the greateſt civil offices were ſtyled ever after, *conſulares, cenſorii, &c.*

CENTURIPÆ, Centoripa, or Centuripe, in *Ancient Geography*, a town in the ſouth-weſt of the territory of Etna, on the river Cyamaſorus: Now *Centorbi* or *Centurippi*. It was a democratical city, which, like Syracuſe, received its liberty from Timoleon. Its inhabitants cultivated the fine arts, particularly ſculpture and engraving. In digging for the remains of antiquities, cameos are nowhere found in ſuch abundance as at Centurippi and its environs. The ſituation of the place is romantic: it is built on the ſummit of a vaſt group of rocks, which was probably choſen as the moſt difficult of acceſs, and conſequently the propereſt in times of civil commotion. The remains ſtill exiſting of its ancient bridge are a proof of its having been a conſiderable city. Cicero ſpeaks of it as ſuch. It was taken by the Romans, plundered and oppreſſed by Verres, deſtroyed by Pompey, and reſtored by Octavius, who made it the reſidence of a Roman colony.

CENTURY, in a general ſenſe, any thing divided into, or conſiſting of, a hundred parts.

The marquis of Worceſter publiſhed a *Century* of inventions, (for a ſpecimen of which, ſee Acoustics,) and Dr Hooke has given a *decimate* of inventions, as part of a *Century*, of which he affirmed himſelf maſter. It is remarkable, that both in the century of the former, and the decimate of the latter, we find the principle on which Savary's fire or ſteam engine is founded. See *Steam-Engine*.

Century, in antiquity. The Roman people, when they were aſſembled for the electing of magiſtrates, enacting of laws, or deliberating upon any public affair, were always divided into centuries, and voted by centuries, in order that their votes might be the more eaſily collected, whence theſe aſſemblies were called *comitia centuriata*. The Roman cohorts were alſo divided into centuries. See Centurion and Cohort.

Century, in *Chronology*, the ſpace of 100 years. This method of computing by centuries is generally obſerved in church hiſtory, commencing from the time of our Saviour's incarnation: in which ſenſe we ſay the firſt century, the ſecond century, &c.

Centuries of Magdeburg, a famous eccleſiaſtical hiſtory, ranged into 13 centuries, carried down to the year 1298, compiled by ſeveral hundred proteſtants of Magdeburg, the chief of whom was Flacius Illyricus.

CENTUSSIS, in Roman antiquity, a coin containing 100 aſſes.

CENTZONTLI, in *Ornithology*, the Mexican name of the *Turdus polyglottus*. See Turdus, Ornithology *Index*.

CEODES, in *Botany*: A genus of the diœcia order, belonging to the polygamia claſs of plants. There is no calyx; the corolla is monopetalous, with a ſhort turbinated tube; the ſtamina are ten ſubulated filaments; the antheræ roundiſh.

CEORLES, the name of one of the claſſes or orders into which the people were diſtinguiſhed among the Anglo-Saxons. The ceorles, who were perſons completely free, and deſcended from a long race of freemen, conſtituted a middle claſs between the labourers and mechanics (who were generally ſlaves, or deſcended from ſlaves), on the one hand, and the nobility on the other. They might go where they pleaſed, and purſue any way of life that was moſt agreeable to their humour; but ſo many of them applied to agriculture, and farming the lands of the nobility, that a ceorl was the moſt common name for a huſbandman or farmer in the Anglo-Saxon times. Theſe ceorls, however, ſeem in general to have been a kind of gentlemen farmers; and if any one of them proſpered ſo well as to acquire the property of five hydes of land, upon which he had a church, a kitchen, a bell-houſe, and great gate, and obtained a ſeat and office in the king's court, he was eſteemed a nobleman or thane. If a ceorl applied to learning, and attained to prieſt's orders, he was alſo conſidered as a thane; his weregild, or price of his life, was the ſame, and his teſtimony had the ſame weight in a court of juſtice. When he applied to trade, and made three voyages beyond ſea, in a ſhip of his own, and with a cargo belonging to himſelf, he was alſo advanced to the dignity of a thane. But if a ceorl had a greater propenſity to arms than to learning, trade, or agriculture, he then became the fithcunman, or military retainer, to ſome potent and warlike earl, and was called the *huſcarle* of ſuch an earl. If one of theſe huſcarles acquitted himſelf ſo well as to obtain from his patron either five hydes of land, or a gilt ſword, helmet, and breaſtplate, as a reward of his valour, he was likewiſe conſidered as a thane. Thus the temple of honour ſtood open to theſe ceorls, whether they applied themſelves to agriculture, commerce, letters, or arms, which were then the only profeſſions eſteemed worthy of a freeman.

CEOS, Cea, Cia, or Cos, in *Ancient Geography*, one of the Cyclades, lies oppoſite to the promontory of Achaia called *Sunium*, and is 50 miles in compaſs. This iſland is commended by the ancients for its fertility and the richneſs of its paſtures. The firſt ſilk ſtuffs, if

Pliny and Solinus are to be credited, were wrought here. Ceos was particularly famous for the excellent figs it produced. It was firſt peopled by Ariſtæus, the ſon of Apollo and Cyrene, who being grieved for the death of his ſon Actæon, retired from Thebes, at the perſuaſion of his mother, and went over with ſome Thebans to Ceos, at that time uninhabited. Diodorus Siculus tells us, that he retired to the iſland of Cos; but the ancients, as Servius obſerves, called both theſe iſlands by the name of Cos. Be that as it will, the iſland of Ceos became ſo populous, that a law prevailed there, commanding all perſons upwards of ſixty to be poiſoned, that others might be able to ſubſiſt; ſo that none above ſixty were to be ſeen in the iſland, being obliged, after they arrived at that age, either to ſubmit to the law, or abandon the country, together with their effects. Ceos had, in former times, four famous cities, viz. Julis, Carthæa, Coreſſus, and Præeſſa. The two latter were, according to Pliny, ſwallowed up by an earthquake. The other two flouriſhed in Strabo's time. Carthæa ſtood on a riſing ground, at the end of a valley, about three miles from the ſea. The ſituation of it agrees with that of the preſent town of Zea, which gives name to the whole iſland. The ruins both of Carthæa and Julis are ſtill remaining; thoſe of the latter take up the whole mountain, and are called by the modern inhabitants Polis, that is, *the city*. Near this place are the ruins of a ſtately temple, with many pieces of broken pillars, and ſtatues of moſt exquiſite workmanſhip. The walls of the city were of marble, and ſome pieces are ſtill remaining above 12 feet in length. Julis was, according to Strabo, the birth-place of Simonides, Bacchylides, Eraſiſtratus, and Ariſto. The Oxford marbles tell us, that Simonides, the ſon of Leoprepis, invented a ſort of artificial memory, the principles of which he explained at Athens; and add, that he was deſcended of another Simonides, who was a poet no leſs renowned than himſelf. One of theſe two poets invented thoſe melancholy verſes which were ſung at funerals, and are called by the Latins *næniæ*. Strabo ſays, that the Athenians, having beſieged the city of Julis, raiſed the ſiege, upon advice that the inhabitants had reſolved to murder all the children under a certain age, that uſeful perſons might not be employed in looking after them. Ceos was, with the other Greek iſlands, ſubdued by the Romans, and beſtowed upon the Athenians by Mark Antony the triumvir, together with Ægina, Tinos, and ſome other adjoining iſlands, which were all reduced to one Roman province by Veſpaſian. The iſland is now called *Zea*.

CEPA, the ONION. See ALLIUM, BOTANY *Index*.

CEPHALANTHUS, BUTTON-WOOD. See BOTANY *Index*.

CEPHALIC, in a general meaning, ſignifies any thing belonging to the head.

CEPHALIC *Medicines*, are remedies for diſorders of the head. Cordials are comprehended herein, as are alſo whatever promotes a free circulation of the blood through the brain.

Except when the diſorder ariſes from exceſs of heat, or an inflammatory diſpoſition in the head, moiſt topicals ſhould never be uſed, but always dry ones.

To rub the head after it is ſhaved proves an inſtantaneous cure for a cephalalgia, a ſtuffing of the head, and a weakneſs of the eyes, ariſing from a weak and relaxed ſtate of the fibres. And as by every freſh evacuation of the humours their quantity is not only leſſened, but alſo their recrementitious parts derived thither, the more frequently the head is ſhaved, the larger quantity of humour is diſcharged; ſo that the frequent ſhaving of the head and beard is likewiſe a perpetual bliſter; and in as much as it is uſeful, it is a cephalic.

CEPHALIC *Vein*, in *Anatomy*, creeps along the arm between the ſkin and the muſcles, and divides it into two branches; the external goes down to the wriſt, where it joins the baſilica, and turns up to the back of the hand; the internal branch, together with a ſmall one of the baſilica, makes the mediana.

The ancients uſed to open this vein for diſorders of the head, for which reaſon it bears this name; but a better acquaintance with the circulation of the blood informs us that there is no foundation for ſuch a notion.

CEPHALENIA, or CEPHALLENIA, an iſland of the Ionian ſea, between Ithaca and Zacynthus, known in Homer's time by the names of Samos and Epirus Melæna, is about eighty miles in length, forty in breadth, and a hundred and thirty in compaſs. It had anciently four cities, one of which bore the name of the iſland. Strabo tells us, that in his time there were only two cities remaining; but Pliny ſpeaks of three; adding, that the ruins of Same, which had been deſtroyed by the Romans, were ſtill in being. Same was the metropolis of the iſland, and is ſuppoſed to have ſtood in the place which the Italians call Porto Guiſcardo. The names of the four cities were, according to Thucydides, Same, Prone, Cranii, and Palæ. This iſland was ſubdued by the Thebans, under the conduct of Amphitryo, who is ſaid to have killed Pterelas, who then reigned here. While Amphitryo was carrying on the war in Cephalenia, then called Samos, one Cephalus, a man of great diſtinction at Athens, having accidentally killed his wife Procris in ſhooting at a deer, fled to Amphitryo, who, pitying his caſe, not only received him kindly, but made him governor of the iſland, which henceforth was called Cephalenia. After it had been long in ſubjection to the Thebans, it fell under the power of the Macedonians, and was taken from them by the Ætolians, who held it till it was reduced by M. Fulvius Nobilior, who having gained the metropolis after a four months ſiege, ſold all the citizens for ſlaves, adding the whole iſland to the dominions of the republic. Now called CEPHALONIA.

CEPHALONIA, the capital of an iſland of the ſame name, ſituated in the Mediterranean, near the coaſt of Epirus, and ſubject to the Venetians. E. Long. 21. N. Lat. 30. 30.

CEPHEUS, in fabulous hiſtory, a king of Arcadia, on whoſe head Minerva faſtening one of Meduſa's hairs, he was rendered invincible.

CEPHEUS, in *Aſtronomy*, a conſtellation of the northern hemiſphere. See ASTRONOMY, Nº. 406.

CERAM, an iſland in the Indian ocean, between the Molucca iſlands on the north, and thoſe of Amboyna and Banda on the ſouth, lying between E. Long. 126. and 129. in S. Lat. 3. It is about 150 miles long, and 60 broad; and here the Dutch have a fortreſs, which keeps the natives in ſubjection.

CERAMBYX, in *Zoology*, a genus of inſects of the beetle kind, belonging to the order of inſects coleoptera. See Entomology *Index*.

CERASTES, in *Zoology*, the trivial name of a ſpecies of Anguis and Coluber. See Ophiology *Index*.

CERASTIUM, mouse-ear, See Botany *Index*.

CERASUS. See Prunus, Botany *Index*.

CERATE, in *Pharmacy*, a thickiſh kind of ointment, applied to ulcerations, excoriations, &c. See Pharmacy *Index*.

CERATION, the name given by the ancients to the ſmall ſeeds of ceratonia, uſed by the Arabian phyſicians as a weight to adjuſt the doſes of medicines; as the grain weight with us took its riſe from a grain of barley.

Ceration, or *ceratium*, was alſo a ſilver coin, equal to one-third of an obolus.

CERATOCARPUS, See Botany *Index*.

CERATONIA, the Carob Tree, or *St John's bread*. See Botany *Index*. The pods of this plant are called *St John's bread*, from an ill founded aſſertion of ſome writers on Scripture, that theſe were the locuſts which St John ate with his honey in the wilderneſs.

CERATOPHYLUM. See Botany *Index*.

CERAUNIA, Ceraunias, or Ceraunius *Lapis*, in *Natural Hiſtory*, a ſort of flinty ſtone, of no certain colour, but of a pyramidical or wedge-like figure; popularly ſuppoſed to fall from the clouds in the time of thunder-ſtorms, and to be poſſeſſed of divers notable virtues, as promoting ſleep, preſerving from lightning, &c. The word is from the Greek κεραυνος, *thunderbolt*. The ceraunia is the ſame with what is otherwiſe called the thunder-ſtone, or thunder-bolt; and alſo ſometimes *ſagitta* or arrow's head, on account of its ſhape. The cerauniæ are frequently confounded with the ombriæ and brontiæ, as being all ſuppoſed to have the ſame origin. The generality of naturaliſts take the ceraunia for a native ſtone, formed among the pyrites, of a ſaline, concrete, mineral juice. Mercatus and Dr Woodward aſſert it to be artificial, and to have been faſhioned thus by tools. The ceraunia, according to theſe authors, are the heads of the ancient weapons of war, in uſe before the invention of iron; which, upon the introduction of that metal, growing into diſuſe, were diſperſed in the fields through this and the neighbouring country. Some of them had poſſibly ſerved in the early ages for axes, others for wedges, others for chiſſels; but the greater part for arrow heads, darts, and lances. The ceraunia is alſo held by Pliny for a white or cryſtal-coloured gem, that attracted lightning in itſelf. What this was, is hard to ſay. Prudentius alſo ſpeaks of a yellow ceraunia; by which he is ſuppoſed to mean the carbuncle or pyropus.

CERBERA. See Botany *Index*.

CERBERUS, in fabulous hiſtory, a dreadful three-headed maſtiff, born of Typhon and Echidna, and placed to guard the gates of hell. He fawned upon thoſe who entered, but devoured all who attempted to get back. He was, however, maſtered by Hercules, who dragged him up to the earth, when, in ſtruggling, a foam dropped from his mouth, which produced the poiſonous herb called *aconite* or *wolf's bane*.

Some have ſuppoſed that Cerberus is the ſymbol of the earth, or of all-devouring time; and that its three mouths repreſent the preſent, paſt, and future. The victory obtained by Hercules over this monſter denotes the conqueſt which this hero acquired over his paſſions. Dr Bryant ſuppoſes that Cerberus was the name of a place, and that it ſignified the temple of the Sun; deriving it from *Kir Abor, the place of light*. This temple was called alſo *Tor-Caph-El*, which was changed to τρικηρηλος; and hence Cerberus was ſuppoſed to have had three heads. It was likewiſe called *Tor-Keren, Turris Regia*; whence τρι καρηνος, from τρεις, *three*, and καρηνον, *head*.

CERCELE, in *Heraldry*: a croſs cercele is a croſs which, opening at the ends, turns round both ways like a ram's horn. See Cross.

CERCIS, the Judas-tree. See Botany *Index*.

CERCOPITHECI, in *Natural Hiſtory*, the name given by Mr Ray to monkeys, or the claſs of apes with long tails See Simia, Mammalia *Index*.

CERDA, John Lewis de la, a learned Jeſuit of Toledo, wrote large commentaries on Virgil, which have been much eſteemed; alſo ſeveral other works. He died in 1643, aged 80.

CERDONIANS, ancient heretics, who maintained moſt of the errors of Simon Magus, Saturninus, and the Manichees. They took their name from their leader *Cerdon*, a Syrian, who came to Rome in the time of Pope Hyginus, and there abjured his errors; but in appearance only; for he was afterwards convicted of perſiſting in them, and accordingly caſt out of the church again. Cerdon aſſerted two principles, the one good and the other evil; this laſt, according to him, was the creator of the world, and the god that appeared under the old law. The firſt, whom he called *unknown*, was the father of Jeſus Chriſt; who, he taught, was incarnate only in appearance, and was not born of a virgin; nor did he ſuffer death but in appearance. He denied the reſurrection, and rejected all the books of the Old Teſtament, as coming from an evil principle. Marcion, his diſciple, ſucceeded him in his errors.

CEREALIA, in *Antiquity*, feaſts of Ceres, inſtituted by Triptolemus, ſon of Celeus king of Eleuſine in Attica, in gratitude for his having been inſtructed by Ceres, who was ſuppoſed to have been his nurſe, in the art of cultivating corn and making bread.

There were two feaſts of this kind at Athens; the one called *Eleuſinia*, the other *Theſmophoria*. See the article Eleusinia. What both agreed in, and was common to all the *cerealia*, was, that they were celebrated with a world of religion and purity; ſo that it was eſteemed a great pollution to meddle, on thoſe days, in conjugal matters. It was not Ceres alone that was honoured here, but alſo Bacchus. The victims offered were hogs, by reaſon of the waſte they make in the products of the earth: whether there was any wine offered or not, is matter of much debate among the critics. Plautus and Macrobius ſeem to countenance the negative ſide; Cato and Virgil the poſitive. Macrobius ſays, indeed, they did not offer wine to Ceres, but *mulſum*, which was a compoſition of wine and honey boiled up together: that the ſacrifice

crifice made on the 21ſt of December to that goddeſs and Hercules, was a pregnant ſow, together with cakes and mulſum; and that this is what Virgil means by *Mili Baccho*. The *cerealia* paſſed from the Greeks to the Romans, who held them for eight days ſucceſſively; commencing, as generally held, on the fifth of the ides of April. It was the women alone who were concerned in the celebration, all dreſſed in white: the men, likewiſe in white, were only ſpectators. They ate nothing till after ſun ſet; in memory of Ceres, who in her ſearch after her daughter took no repaſt but in the evening.

After the battle of Cannæ, the deſolation was ſo great at Rome, that there were no women to celebrate the feaſt, by reaſon they were all in mourning; ſo that it was omitted that year.

Cerealia, in *Botany*, from *Ceres*, the goddeſs of corn; Linnæus's name for the larger eſculent ſeeds of the graſſes: theſe are rice, wheat, rye, barley, oats, millet, panic graſs, Indian millet, holcus, zizania, and maize. To this head may be likewiſe referred darnel (*lolium*); which, by preparation, is rendered eſculent.

CEREBELLUM, the hinder part of the head. See Anatomy *Index*.

CEREBRUM, the brain. Its ſtructure and uſe are not ſo fully known as ſome other parts of the body; and different authors conſider it in various manners. However, according to the obſervations of thoſe moſt famed for their accuracy and dexterity in anatomical inquiries, its general ſtructure is as given in Anatomy *Index*.

Dr Hunter obſerves, that the principal parts of the medullary ſubſtance of the brain in idiots and madmen, ſuch as the *thalami nervorum opticorum*, and *medulla oblongata*, are found entirely changed from a medullary to a hard, tough, dark-coloured ſubſtance, ſometimes reſembling white leather.

CEREMONIAL (*ceremoniale*) a book in which is preſcribed the order of the ceremonies to be obſerved in certain actions and occaſions of ſolemnity and pomp. The ceremonial of the Roman church is called *ordo Romanus*. It was publiſhed in 1516 by the biſhop of Corcyra; at which the college of cardinals were ſo ſcandalized, that ſome of them voted to have the author as well as book burnt, for his temerity in expoſing the ſacred ceremonies to the eyes of profane people.

Ceremonial, is alſo uſed for the ſet or ſyſtem of rules and ceremonies which cuſtom has introduced for regulating our behaviour, and which perſons practiſe towards each other, either out of duty, decency, or civility.

Ceremonial, in a more particular ſenſe, denotes the manner in which princes and ambaſſadors uſed to receive and to treat one another. There are endleſs diſputes among ſovereigns about the *ceremonial*: ſome endeavouring to he on a level, and others to be ſuperior; inſomuch that numerous ſchemes have been propoſed for ſettling them. The chief are, 1. To accommodate the difference by compromiſe or alternation; ſo that one ſhall precede now, the other the next time; or one in one place, and the other in another: 2. By ſeniority; ſo that an elder prince in years ſhall precede a younger, without any other diſtinction, Theſe expedients, however, have not yet been accepted by any, except ſome *alternate princes*, as they are called, in Germany.

Ceremonial is more particularly uſed in ſpeaking of the laws and regulations given by Moſes relating to the worſhip of God among the ancient Jews. In this ſenſe it amounts to much the ſame with what is called the *Levitical law*, and ſtands contradiſtinguiſhed from the moral as well as judicial law.

CEREMONY, an aſſemblage of ſeveral actions, forms, and circumſtances, ſerving to render a thing more magnificent and ſolemn.

In 1646, M. Ponce publiſhed a hiſtory of ancient ceremonies, tracing the riſe, growth, and introduction of each rite into the church, and its gradual advancement to ſuperſtition therein. Many of them were borrowed from Judaiſm; but more ſeemingly from Paganiſm. Dr Middleton has given a fine diſcourſe on the conformity between the Pagan and Popiſh ceremonies, which he exemplifies in the uſe of incenſe, holy water, lamps, and candles, before the ſhrines of ſaints, votive gifts or offerings round the ſhrines of the deceaſed, &c. In effect, the altars, images, croſſes, proceſſions, miracles, and legends; nay, even the very hierarchy, pontificate, religious orders, &c. of the preſent Romans, he ſhows, are all copied from their heathen anceſtors.—We have an ample and magnificent account of the religious ceremonies and cuſtoms of all nations in the world, repreſented in figures deſigned by Picart, with hiſtorical explanations, and many curious diſſertations.

Maſter of the Ceremonies, an officer inſtituted by King James I. for the more honourable reception of ambaſſadors and ſtrangers of quality. He wears about his neck a chain of gold, with a medal under the crown of Great Britain, having on one ſide an emblem of peace, with this motto, *Beati pacifici*; and on the other, an emblem of war, with *Dieu et mon droit*; his ſalary is 300l. per annum.

Aſſiſtant Maſter of the Ceremonies, is to execute the employment in all points, whenſoever the maſter of the ceremonies is abſent. His ſalary is 141l. 13s. 4d. per annum.

Marſhal of the Ceremonies, is their officer, being ſubordinate to them both. His ſalary is 100l. per annum.

CERENZA, a town of Italy, in the kingdom of Naples, and in the Hither Calabria, with a biſhop's ſee. It is ſeated on a rock, in E. Long. 17. 5. N. Lat. 39. 23.

CERES, a pagan deity, the inventor or goddeſs of corn; in like manner as Bacchus was of wine.

According to the poets, ſhe was the daughter of Saturn and Ops, and the mother of Proſerpine, whom ſhe had by Jupiter. Pluto having ſtolen away Proſerpine, Ceres travelled all over the world in queſt of her daughter, by the help of a torch, which ſhe had lighted in Mount Ætna.

As Ceres was thus travelling in ſearch of her daughter, ſhe came to Celeus king of Eleuſis, and undertook to bring up his infant ſon Triptolemus. Being deſirous to render her charge immortal, ſhe fed him in the day time with divine milk, and in the night covered him with fire. Celeus obſerving an unuſual improvement in his ſon, reſolved to watch his nurſe;

to which end he hid himſelf in that part of the houſe where ſhe uſed to cover the child with fire: but when he ſaw her put the infant under the embers, he cried out and diſcovered himſelf. Ceres puniſhed the curioſity and indiſcretion of the father with death. Afterwards ſhe taught the youth the art of ſowing corn and other fruits, and mounted him in a chariot drawn by winged dragons, that he might traverſe the world, and teach mankind the uſe of corn and fruits. After this, having diſcovered, by means of the nymph Arethuſa, that Proſerpine was in the infernal regions, ſhe applied to Jupiter, and obtained of him that Proſerpine ſhould be reſtored, on condition that ſhe had taſted nothing during her ſtay in that place: but it being diſcovered, by the information of Aſcalaphus, that, as ſhe was walking in Pluto's orchard, ſhe had gathered an apple, and had taſted of ſome of the ſeeds, ſhe was for ever forbidden to return. Ceres, out of revenge, turned Aſcalaphus into an owl. At length, Jupiter, to mitigate her grief, permitted that Proſerpine ſhould paſs one half of the year in the infernal regions with Pluto, and the other half with her mother on earth.

Cicero ſpeaks of a temple of Ceres at Catanea in Sicily, where was a very ancient ſtatue of that goddeſs, but entirely concealed from the ſight of men, every thing being performed by matrons and virgins.

CERET, a town of France in Rouſſillon, with a magnificent bridge of a ſingle arch. It is ſeated near the river Tec, in E. Long. 2. 46. N. Lat. 42. 23.

CEREUS, in *Botany*. See CACTUS.

CERIGO, an iſland in the Archipelago, anciently called *Cytherea*; noted for being the birth-place of Helen, and, as the poets ſay, of Venus. At preſent there is nothing very delightful in the place; for the country is mountainous, and the ſoil dry. It abounds in hares, quails, turtle, and excellent falcons. It is about 50 miles in circumference, and had formerly good towns; but there is now none remaining but that which gives name to the iſland. This is ſtrong both by art and nature, it being ſeated on a craggy rock. The inhabitants are Greek Chriſtians, and ſubject to the Venetians, who keep a governor there, whom they change every two years.

CERINES, a town in the iſland of Cyprus, with a good caſtle, a harbour, and a biſhop's ſee. E. Long. 33. 35. N. Lat. 35. 22.

CERINTHE, HONEYWORT. See BOTANY *Index*.

CERINTHIANS, ancient heretics, who denied the deity of Jeſus Chriſt.—They took their name from Cerinthus, one of the firſt hereſiarchs in the church, being contemporary with St John. See CERINTHUS.

They believed that Jeſus Chriſt was a mere man, born of Joſeph and Mary; but that, in his baptiſm, a celeſtial virtue deſcended on him in form of a dove; by means whereof he was conſecrated by the Holy Spirit, and made Chriſt. It was by means of this celeſtial virtue, therefore, that he wrought ſo many miracles; which, as he received it from heaven, quitted him after his paſſion, and returned to the place whence it came; ſo that Jeſus, whom they called a *pure man*, really died and roſe again; but that Chriſt, who was diſtinguiſhed from Jeſus, did not ſuffer at all. It was partly to refute this ſect that St John wrote his goſpel. They received the goſpel of St Matthew, to countenance their doctrine of circumciſion, from Chriſt's being circumciſed; but they omitted the genealogy. They diſcarded the epiſtles of St Paul, becauſe that apoſtle held circumciſion aboliſhed.

CERINTHUS, a hereſiarch, cotemporary with the apoſtles, aſcribed the creation not to God, but to angels. He taught that Jeſus Chriſt was the ſon of Joſeph, and that circumciſion ought to be retained under the goſpel. He is looked upon as the head of the converted Jews, who raiſed in the church of Antioch the tumult of which St Luke has given the hiſtory in the 15th chapter of the Acts. Some authors aſcribe the book of the Apocalypſe to Cerinthus; adding, that he put it off under the name of St John, the better to authoriſe his reveries touching Chriſt's reign upon earth: and it is even certain that he publiſhed ſome works of this kind under the title of *Apocalypſe*. See APOCALYPSE.

CEROPEGIA. See BOTANY *Index*.

CERTHIA, in *Ornithology*, the CREEPER or OX-EYE, a genus belonging to the order of picæ. See ORNITHOLOGY.

CERTIFICATE, *Trial by*, in the law of England, a ſpecies of trial allowed in ſuch caſes where the evidence of the perſon certifying is the only proper criterion of the point in diſpute *. For when the fact in queſtion lies out of the cognizance of the court, the judges muſt rely on the ſolemn averment or information of perſons in ſuch a ſtation as affords them the moſt clear and competent knowledge of the truth. As therefore ſuch evidence, if given to a jury, muſt have been concluſive, the law, to ſave trouble and circuity, permits the fact to be determined upon ſuch certificate merely. Thus, 1. If the iſſue be whether A was abſent with the king in his army out of the realm in time of war, this ſhall be tried by the certificate of the mareſchal of the king's hoſt in writing under his ſeal, which ſhall be ſent to the juſtices. 2. If, in order to avoid an outlawry, or the like, it was alleged that the defendant was in priſon, *ultra mare*, at Bourdeaux, or in the ſervice of the mayor of Bourdeaux, this ſhould have been tried by the certificate of the mayor, and the like of the captain of Calais. But when this was law, thoſe towns were under the dominion of the crown of England. And therefore, by a parity of reaſon, it ſhould now hold, that in ſimilar caſes ariſing at Jamaica or Minorca, the trial ſhould be by certificate from the governor of thoſe iſlands. We alſo find that the certificate of the queen's meſſengers, ſent to ſummon home a peereſs of the realm, was formerly held a ſufficient trial of the contempt in refuſing to obey ſuch ſummons. 3. For matters within the realm; the cuſtoms of the city of London ſhall be tried by the certificate of the mayor and aldermen, certified by the mouth of their recorder, upon a ſurmiſe from the party alleging it, that the cuſtom ought to be thus tried; elſe it muſt be tried by the country: As, the cuſtom of diſtributing the effects of freemen deceaſed; of enrolling apprentices, or that he who is free of one trade may uſe another; if any of theſe, or other ſimilar points come in iſſue. 4. The trial of all cuſtoms and practice of the courts ſhall be by certificate from the proper officers of thoſe courts reſpectively; and

* See *Trial*.

Blackſt. Comment.

and when return was made on a writ by the ſheriff or under ſheriff, ſhall be only tried by his own certificate.

CERTIORARI, in *Law*, a writ which iſſues out of the chancery, directed to an inferior court, to call up the records of a cauſe there depending, in order that juſtice may be done. And this writ is obtained upon complaint, that the party who ſeeks it has received hard uſage, or is not like to have an impartial trial in the inferior court. A certiorari is made returnable either in the king's bench, common pleas, or in chancery.

It is not only uſed out of the court of chancery, but likewiſe out of the king's bench; in which laſt mentioned court it lies where the king would be certified of a record. Indictments from inferior courts, and proceedings of the quarter-ſeſſions of the peace, may alſo be removed into the king's bench by a certiorari: and here the very record muſt be returned, and not a tranſcript of it; though uſually in chancery, if a certiorari be returnable there, it removes only the tenor of the record.

CERTITUDE, conſidered in the things or ideas which are the objects of our underſtanding, is a neceſſary agreement or diſagreement of one part of our knowledge with another: as applied to the mind, it is the perception of ſuch agreement or diſagreement; or ſuch a firm well-grounded aſſent, as excludes not only all manner of doubt, but all conceivable poſſibility of a miſtake.

There are three ſorts of certitude, or aſſurance, according to the different natures and circumſtances of things. 1. A phyſical or natural certitude, which depends upon the evidence of ſenſe; as that I ſee ſuch or ſuch a colour, or hear ſuch or ſuch a ſound; nobody queſtions the truth of this, where the organs, the medium, and the object, are rightly diſpoſed. 2. Mathematical certitude, is that ariſing from mathematical evidence; ſuch as, that the three angles of a triangle are equal to two right ones. 3. Moral certitude is that founded on moral evidence, and is frequently equivalent to a mathematical one; as that there was formerly ſuch an emperor as Julius Cæſar, and that he wrote the commentaries which paſs under his name; becauſe the hiſtorians of theſe times have recorded it, and no man has ever diſproved it ſince: this affords a moral certitude, in common ſenſe ſo great, that one would be thought a fool or a madman for denying it.

CERTOSA, a celebrated Carthuſian monaſtery, in the territory of the Paveſe, in the duchy of Milan, four miles from Pavia: its park is ſurrounded with a wall 20 miles in circumference; but there are ſeveral ſmall towns and villages therein.

CERVANTES. See SAAVEDRA.

CERVERA, a town of Spain in Catalonia, ſeated on a ſmall river of the ſame name, in E. Long. 1. 9. N. Lat. 41. 28.

CERVIA, a ſea port town of Italy, in Romagna, with a biſhop's ſee, ſeated on the gulf of Venice, in E. Long. 13 5. N. Lat. 44. 16.

CERVICAL NERVES, are ſeven pair of nerves, ſo called, as having their origin in the *cervix*, or neck.

CERVICAL *Veſſels*, among anatomiſts, denote the arteries, veins, &c. which paſs through the *vertebræ* and muſcles of the neck up to the ſkull.

CERVIX, in *Anatomy*, properly denotes the hind part of the neck; as contradiſtinguiſhed from the fore part, which is called *jugulum*, or the throat.

CERVIX of the *Scapula*, denotes the head of the ſhoulder blade, or that upper proceſs whoſe *ſinus* receives the head of the *humerus*.

CERVIX *of the Uterus*, the neck of the *uterus*, or that oblong canal or paſſage between the internal and external orifices, which receives and encloſes the *penis* like a ſheath, whence it is alſo called VAGINA.

CERUMEN, a thick, viſcous, bitter, excrementitious humour, ſeparated from the blood by proper glands placed in the *meatus auditorius*, or outer paſſage of the ear.

CERUSS, WHITE LEAD, a ſort of calx of lead, made by expoſing plates of that metal to the vapour of vinegar. See CHEMISTRY *Index*.

Ceruſs, as a medicine, is uſed externally, either mixed in ointments, or by ſprinkling it on old gleeting and watery ulcers, and in many diſeaſes of the ſkin. If, when it is reduced into a fine powder, it is received in with the breath in inſpiration, and carried down into the lungs, it cauſes incurable aſthmas. Inſtances of the very pernicious effects of this metal are too often ſeen among thoſe perſons who work lead in any form, but particularly among the workers in white lead.

The painters uſe it in great quantities; and that it may be afforded cheap to them, it is generally adulterated with common whiting.

CERVUS, or DEER, in *Zoology*, a genus of quadrupeds belonging to the order of Pecora. See MAMMALIA *Index*.

CERVUS *Volans*, in *Natural Hiſtory*, a name given by authors to the ſtag fly, or horned beetle, a very large ſpecies of beetle with horns ſloped, and ſomething like thoſe of the ſtag.

CERYX, in antiquity. The ceryces were a ſort of public criers appointed to proclaim or publiſh things aloud in aſſemblies. The *ceryx* among the Greeks anſwered to the *præco* among the Romans. Our criers have only a ſmall part of their office and authority.

There were two kinds of ceryces, *civil* and *ſacred*. The former were thoſe appointed to call aſſemblies, and make ſilence therein; alſo to go on meſſages, and do the office of our heralds, &c. The ſacred ceryces were a ſort of prieſts, whoſe office was to proclaim ſilence in the public games and ſacrifices, publiſh the names of the conquerors, proclaim feaſts, and the like. The prieſthood of the ceryces was annexed to a particular family, the deſcendants of Ceryx, ſon of Eumolpus. To them it alſo belonged to lead ſolemn victims to ſlaughter. Before the ceremonies began, they called ſilence in the aſſembly, by the formula, Ευφημειτε σιγε πας εσω λαως; anſwering to the *favete linguis* of the Romans. When the ſervice was over, they diſmiſſed the people with this formula, Δαων αφεσις, *Ite, miſſa eſt*.

CESARE, among logicians, one of the modes of the ſecond figure of ſyllogiſms; the minor propoſition of which is an univerſal affirmative, and the other two univerſal negatives: thus,

CE No immoral books ought to be read;
SA But every obſcene book is immoral;
RE Therefore no obſcene books ought to be read.

CESENA, a town of Romagna in Italy, with a biſhop's ſee, ſubject to the pope, and ſeated on the river Savio, in E. Long. 12. 46. N. Lat. 44. 8.

CESPITOSÆ PLANTÆ (from *ceſpes*, turf or ſod), are thoſe plants which produce many ſtems from one root, and thence form a cloſe thick carpet on the ſurface of the earth.

Cespitosæ Paludes, turf bogs.

CESSATION, the act of intermitting, diſcontinuing, or interrupting, the courſe of any thing, work, action, or the like.

Cessation of Arms, an armiſtice or occaſional truce. See TRUCE.

When the commander of a place finds things reduced to an extremity, ſo that he muſt either ſurrender, or ſacrifice the garriſon and inhabitants to the mercy of the enemy, he plants a white flag on the breach, or beats the chamade; on which a ceſſation of arms and hoſtilities commences, to give room for a capitulation.

CESSIO BONORUM, in *Scots Law*, the name of that action by which an inſolvent debtor may apply for liberation from priſon, upon making over his whole real and perſonal eſtate to his creditors

CESSION, in *Law*, an act by which a perſon ſurrenders and tranſmits to another perſon a right which belonged to himſelf. Ceſſion is more particularly uſed in the civil law for a voluntary ſurrender of a perſon's effects to his creditors to avoid impriſonment. See the article BANKRUPT.

In ſeveral places the ceſſion carried with it a mark of infamy, and obliged the perſon to wear a green cap or bonnet; at Lucca, an orange one; to neglect this was to forfeit the privileges of the *Ceſſion*. This was originally intended to ſignify that the ceſſionary was become poor through his own folly. The Italian lawyers deſcribe the ceremony of ceſſion to conſiſt in ſtriking the bare breech three times againſt a ſtone, called *Lapis Vituperii*, in preſence of the judge. Formerly it conſiſted in giving up the girdles and keys in court: the ancients uſing to carry at their girdles the chief utenſils wherewith they got their living; as the ſcrivener his eſcritoire, the merchant his bag, &c. The form of ceſſion among the ancient Gauls and Romans was as follows: The ceſſionary gathered up duſt in his left hand from the four corners of the houſe, and ſtanding on the threſhold, holding the door-poſt in his right hand, threw the duſt back over his ſhoulders; then ſtripping to his ſhirt, and quitting his girdle and bags, he jumped with a pole over a hedge; hereby letting the world know that he had nothing left, and that when he jumped, all he was worth was in the air with him. This was the ceſſion in criminal matters. In civil caſes, it was ſufficient to lay a broom, a ſwitch, or a broken ſtraw, on the threſhold: this was called *chrenecruda per durpillum et feſtucam*.

CESSION, in the eccleſiaſtical law, is when an eccleſiaſtical perſon is created a biſhop, or when a parſon of a pariſh takes another benefice, without diſpenſation, or being otherwiſe qualified. In both theſe caſes their firſt benefices became void by ceſſion, without any reſignation; and to theſe livings that the perſon had, who was created biſhop, the king may preſent for that time, whoſoever is patron of them; and in the other caſe the patron may preſent: but by diſpenſation of retainder, a biſhop may retain ſome or all the preferments he was entitled to before he was made biſhop.

CESTRUM, BASTARD JASMINE. See BOTANY *Index*.

CESTUI, a French word, ſignifying *he* or *him*, frequently uſed in the Engliſh law writings. Thus, *Ceſtui qui truſt*, a perſon who has lands, &c. committed to him for the benefit of another; and if ſuch perſon does not perform his truſt, he is compellable to it in chancery. *Ceſtui qui vie*, one for whoſe life any lands, &c. are granted. *Ceſtui qui uſe*, a perſon to whoſe uſe any one is infeoffed of lands or tenements. Formerly the feoffees to uſes were deemed owners of the land, but now the poſſeſſion is adjudged *in ceſtui qui uſe*.

CESTUS, among ancient poets, a fine embroidered girdle ſaid to be worn by Venus, to which Homer aſcribes the power of charming and conciliating love. The word is alſo written *ceſtum* and *ceſton*: it comes from κεϛος, *a girdle*, or other thing embroidered or wrought with a needle; derived, according to Servius, from κεντειν, *pungere*; whence alſo *inceſtus*, a term uſed at firſt for any indecency by undoing the girdle, &c. but now reſtrained to that between perſons near a-kin. See INCEST.

CETACEOUS, an appellation given to the fiſhes of the whale kind. See CETOLOGY.

CETE, the name of Linnæus's ſeventh order of mammalia, comprehending the MONODON, BALÆNA, PHYSETER, and DELPHINUS. See CETOLOGY.

CETERACH, the trivial name of a ſpecies of ASPLENIUM. See ASPLENIUM, BOTANY *Index*.

CETOLOGY.

Definition of the title.

UNDER this general title is comprehended the hiſtory of that diviſion of marine animals, which in the Linnæan arrangement conſtitutes the ſeventh order of the claſs mammalia. This is the order *cete* or *whales*. Ray and Willoughby have included this order of animals under the claſs of fiſhes. Ray, in his arrangement of fiſhes, divides them into two principal ſections. The one comprehends thoſe fiſhes which are furniſhed with lungs for reſpiration; and the other, thoſe which breathe by means of gills, and may be conſidered as truly fiſhes. In the former ſection are included the cetaceous fiſhes; and the reaſons which he aſſigns for arranging them in this manner are, that they agree in external form with fiſhes; that they are entirely naked, or covered only with a ſmooth ſkin; and that they live entirely in the water, and have all the actions of fiſhes. Although this tribe of animals reſembles fiſhes, not only in manners and habits, but alſo in being inhabitants of the ſame element, Linnæus thought proper to claſs them with the mammalia,

2 Arrangement of fiſhes by Ray.

3 Of whales by Linnæus,

Introduction.

on account of the ſimilarity of their internal ſtructure, having a double heart and warm blood, and reſpiring like them by means of lungs.

4 By Pennant.

5 Treated ſeparately.

6 Their hiſtory important,

Mr Pennant, in his Britiſh Zoology, has objected to the claſſification of cetaceous animals with the mammalia, as Linnæus has done, becauſe, "to have preſerved the chain of beings entire, he ſays that Linnæus ſhould have made the genus *phocæ* or *ſeals*, and that of the *trichecus* or *manati*, immediately precede the whale, thoſe being the links that connect the mammalia or quadrupeds with the fiſh; for the ſeal is in reſpect to its legs the moſt imperfect of the former claſs; and in the *manati* the hind feet coaleſce, aſſuming the form of a broad horizontal tail." On this account, Mr Pennant has arranged the cetaceous order of animals under his claſs of fiſhes, including them under the firſt diviſion of that claſs. For the ſame reaſons we have ſeparated them from the claſs of fiſhes; but although they reſemble the quadrupeds, which compoſe chiefly the claſs mammalia, in being warm-blooded, and in the functions of circulation and reſpiration; yet, as they poſſeſs characters ſo totally diſtinct from any of the mammalia, we judged it more natural to ſeparate them alſo from this claſs, and to treat of them in the preſent article. This tribe of animals is alſo entitled to a ſeparate treatiſe, both on account of the intereſt to be derived from their natural hiſtory, and on account of their importance in a commercial view.

7 but deficient.

8 Reaſons.

9 Sources of information.

The hiſtory of cetaceous animals, as well as that of the other inhabitants of the ocean, cannot be expected to be complete. They are beyond the reach of the naturaliſt, from the nature of the element in which they live; and even when he is favoured with a tranſient glimpſe, the rapidity of their motions precludes the poſſibility of obtaining much accurate knowledge of their manners and habits. But the abode of the whale is the moſt inacceſſible parts of the ocean. The frozen regions of the north and ſouth are his chief retreat—regions ſo inhoſpitable, as to forbid the approach of the moſt hardy naturaliſt with all his zeal and ardour, and to be viſited only by the adventurous fiſherman, prompted by the hope of gain. To the latter, chiefly, we are indebted for what knowledge we poſſeſs of this tribe of animals. And from men who had a very different object in view, who, in this hazardous trade, had to ſtruggle with the ſevereſt ſeaſons, in a climate where the rigour of winter rarely relaxes, information on this ſubject could neither be accurate nor extenſive. This, however, was the principal ſource from which the earlier writers on this department of natural hiſtory derived their information. Such were Sibbald, Martens, Dudley, Klein, and Anderſon, who compoſed their deſcriptions from the relations and memoirs which were communicated to them by fiſhermen and voyagers. Hence have originated thoſe erroneous and inaccurate details which have been introduced into the works of naturaliſts.

10 Name limited.

Claſſification &c.

11 Different from other fiſhes

12 in fat

13 and quantity of blood.

The name of *Cete*, as the word which is derived from the Greek language originally ſignifies, was given indiſcriminately to all marine animals of extraordinary ſize. It has been limited by later naturaliſts to that tribe of fiſhes which are diſtinguiſhed from other fiſhes by the functions of reſpiration and circulation, and by being viviparous. Theſe are now included under the general term *cetaceous* fiſhes. Beſide the diſcriminative marks of reſpiration, circulation, and being viviparous, others may be mentioned. In the cetaceous fiſhes the ſkin is not covered with ſcales as in other fiſhes; there are one or two orifices in the upper part of the head for diſcharging water; the lateral fins are furniſhed with articulations as in the human hand, and the tail is horizontal. There is another remarkable difference between the cetaceous and other fiſhes, in the greater quantity of blood, and the thick covering of fat or *blubber*, for which the former are diſtinguiſhed. And conſidering the temperature of the climate, and the element in which theſe animals live, this ſeems to be a wiſe and neceſſary proviſion of nature. The great quantity of blood produces a greater degree of heat, and the ſpongy porous maſs of blubber, being from its nature a ſlow conductor of heat, is an excellent defence againſt the rigour of the ſeaſons in the polar regions.

In the following treatiſe, we propoſe to lay before our readers, 1ſt, The Claſſification and Natural Hiſtory of Cetaceous Fiſhes; 2d, Their Anatomy and Phyſiology; and, laſtly, The Hiſtory of the Whale Fiſhery as an object of trade. Theſe ſhall be the ſubjects of three Chapters.

CHAP. I. *Of the Claſſification and Natural Hiſtory of Cetaceous Fiſhes.*

14 Claſſes four.

CETACEOUS fiſhes have been divided into four claſſes, the characters of which are taken from the want of teeth, from the ſtructure of the teeth, and from their poſition in one or both jaws. The following table exhibits the characters of theſe claſſes, with a tranſlation oppoſite for the ſake of the Engliſh reader.

1ſt, BALÆNA, or *Whale.*

Dentium loco laminæ corneæ in maxilla ſuperiore.	In place of teeth there are horny plates in the upper jaw.

2d, MONODON, or *Unicorn Fiſh.*

Dens unicus aut duo in parte antica maxillæ ſuperioris horizontaliter exſerti.	One or two teeth horizontally inſerted in the anterior part of the upper jaw.

3d, PHYSETER, or *Spermaceti Whale.*

Dentes veri in maxilla inferiore; aliquot vero plani, vix conſpicui in maxilla ſuperiore.	Teeth in the lower jaw, but ſcarcely conſpicuous in the upper jaw.

4th, DELPHINUS, or *Dolphin.*

Dentes in utraque maxilla.	Teeth in both jaws.

15 Genera.

Each of the four claſſes which we have now enumerated and characterized, comprehends only a ſingle genus, the characters of which are as follows:

GENERIC CHARACTERS.

1ſt Genus, BALÆNA or *Whale.*

Maxilla ſuperior dentium loco, laminis corneis inſtructa; fiſtula duplex in vertice.	The upper jaw is furniſhed with horny plates in place of teeth, and there are two blow-holes on the top of the head.

2d Genus, Monodon, or *Unicorn Fiſh.*

Dens unicus aut duo, longi aut breves, recti vel recurvi, in parte antica maxillæ ſuperioris exſerti ; fiſtula in occipite.	In the anterior part of the upper jaw there is one or two teeth which are either ſtraight or curved, long or ſhort ; the ſpout in the back part of the head.

3d Genus, Physeter, or *Spermacceti Whale.*

Dentes veri et viſibiles in maxilla inferiore, in quibuſdam vero maxilla ſuperior dentibus planis vix conſpicuis inſtructa ; fiſtulâ in angulo ſuperiore roſtri.	The teeth diſtinctly ſeen in the lower jaw, but ſcarcely viſible in the upper jaw; the ſpout in the upper part of the forehead.

4th Genus, Delphinus, or *Dolphin.*

Maxilla utraque dentata ; fiſtula in fronte.	Both jaws are furniſhed with teeth; the ſpout in the forehead.

Class I. BALÆNA.

Genus 1ſt, Balæna, or *Whale.*

16 Generic characters. The body is naked, elliptical, or of an oblong conical ſhape, and of a black or browniſh colour.

The head is very long, laterally compreſſed, and diminiſhing towards the beak. The opening of the mouth is very large. The jaws are nearly equal, and without teeth ; but in place of teeth, the upper jaw is furniſhed on both ſides with horny plates, tranſverſely diſpoſed. The lower jaw is anteriorly of an oval or roundiſh form, broader than the upper jaw, and having a furrow on the margin for receiving the horny plates. The eyes are ſmall ; they are placed near the inſertion of the lateral fins. The ears are alſo ſmall, and are ſituated behind the eyes.

In ſome of the ſpecies the anterior part of the body is plicated or folded underneath.

The penis is encloſed in a ſheath. The female is furniſhed with two mammæ ; and the organs of generation are placed between them. Behind them is the anus.

There are three or four fins ; two lateral fins, one at the extremity of the tail, which is placed horizontally. The dorſal fin is often wanting.

* *Species which have no Dorſal Fin.*

Plate CXL. fig. 1. 1. Balæna Mysticetus, the *Greenland*, or *large Whalebone Whale.*

French, *Baleine Franche*, *Baleine de grande baie ;* Spaniards, *Vallena ; Whallfeſch*, by the Germans ; *Whallviſck*, Dutch ; *Hvafiſch*, *Sletback*, by the Norwegians ; *Hvalfiſk*, by the Swedes ; *Slitcheback*, *Sandhual*, by the Danes ; *Vatuſkalr*, by the Icelanders ; and *Arbek*, *Arbavirkſouk*, by the Greenlanders.

17 Characters. In this ſpecies the jaws are nearly of equal length ; the lower is of an oval form, and broad in the middle ; the back is ſpotted, black and white.

18 Deſcription. This is the largeſt of animals known. The body, from a ſide-view, appears of an elliptical form. The head is very nearly equal to one-third of the whole length of the body. It is as it were compoſed of two inclined planes joined together under a larger or ſmaller angle, has ſomething the appearance of the roof of a ſmall houſe.

19 Blow-holes. In the middle of the line formed by the junction of the two inclined planes, there riſes a large tubercle, in which are ſituated the ſpouts or blow-holes oppoſite to each other, and curved in the ſhape of the letter S. The jaws are nearly equal in length ; the lower is broader towards the middle of its length than the upper ; and beſides, it ſpreads out and has membranous coverings, which terminate in a broad deep furrow, which is deſtined to receive the horny teeth of the upper jaw. When the jaws are cloſe, the opening of the mouth folds upwards towards the orbit of the eyes, and exhibits by its inflection the curved form of a ſickle.

20 Whalebone. The want of teeth is ſupplied by about 500 horny laminæ. This is the ſubſtance called *whalebone.* They are attached to the upper jaw on both ſides, and ſupported at the baſe by a kind of bone which extends the whole length of the roof of the mouth. They are arranged tranſverſely, and in an oblique direction. Each of them is from three to five feet long, is thickeſt at the baſe, tapers towards the point, is a little curved, and terminates in a fringe of long hair which hangs about the tongue. Towards the two extremities of each row, there are beſides many other ſmall laminæ, which are of a ſquare form, of the thickneſs of a writing quill, and about four inches long. Theſe latter are arranged in the ſame direction as the former ; but are of a ſofter ſubſtance, and do not come ſo cloſe to each other.

21 Tongue. The tongue is ſoft and ſpongy, ſtrongly attached to the lower jaw, and rounded at the extremity. On the upper ſide it is white, but on the ſides it is marked with black ſpots. It is often 10 feet broad and 18 feet long.

22 Eyes. The eyes are placed very low, at the broadeſt part of the head, juſt above the angles of the mouth, and very near the origin of the lateral fins. They are furniſhed, as the means of defence, with eyelids and eyelaſhes ; and reſemble in form and magnitude thoſe of an ox. The cryſtalline lens, which is white and tranſparent, is not larger than a pea. 23 Ear. The external organ of hearing, conſiſts of a ſmall hole of the diameter of a quill, which is placed immediately behind the eyes.

The back forms a gentle curvature from the tubercle on the top of the head ; towards the middle of the trunk it is again elevated, and then tapers gradually to the tail. The lower part of the body diminiſhes in the ſame proportion. 24 Fins. The lateral fins have their origin near the angle of the mouth. They are two large thick maſſes, of an oval irregular form, and are often 10 feet long. The tail fin is divided into two oval fleſhy lobes, which terminate in a point.

The male is furniſhed with a penis which is eight feet long, and ſurrounded with a double ſkin, which gives it ſomething of the appearance of a knife in its ſheath. The female has two mammæ, which are placed on each ſide of the organs of generation.

25 Skin. The ſkin of the whale is divided into the epidermis or ſcarf-ſkin, the true ſkin, the fat or blubber, and the muſcle or fleſh. The epidermis is as thin as parchment,

ment, and very eaſily ſeparated, when the proceſs of putrefaction firſt commences. The true ſkin is an inch thick, and covers a layer of fat of 15 inches.

26 Colour. The back of the whale is uſually of a fine black, marked with whitiſh rays, which have ſome reſemblance to the veins of wood; and in the thickeſt, as well as the fineſt of theſe traces, there paſs other veins of a dirty white. This mixture of colours preſents an agreeable appearance, eſpecially when the back of the fiſh is illuminated with the rays of the ſun. The different changes of colour from white to yellow then exhibit the ſplendour and brilliancy of ſilver.

The under part of the trunk, and of the lower jaw, is of a bright white. But theſe colours are ſubject to conſiderable variation, according to the age of the fiſh. Some have been obſerved to be entirely black; others ſpotted with white, yellow, and brown. Martens aſſures us, that he obſerved on the tail of a whale, the number 1222, as neatly traced, as if it had been executed by the hand of a painter. But probably the reſemblance to thoſe figures was helped out by the aid of fancy.

Ellis and ſome other naturaliſts aſſert, that the whale is found perfectly white in the weſtern parts of the northern ocean. It is not uncommon to ſee the young whale ſpotted with brown; and old whales marked on the back with a tranſverſe band, which extends to the belly. Sometimes, however, the ſpots obſerved on the whale have been undoubtedly occaſioned by wounds; for it is certain, that a white ſcar always remains on the place which has been wounded.

27 Size. The ſize of the whale has not been very accurately aſcertained. Some have been taken of 80, and even of 100 feet long, and almoſt as much in circumference. The female is in general larger than the male. The period of pregnancy is nine or ten months; and one, very rarely two, is brought forth at a time. The young whale is 20 feet long at birth.

28 Haunts. This ſpecies of whale is very common towards the north pole, in the ſeas of Greenland and Spitzbergen, and eſpecially in that part of the arctic ſea which lies under the 76th degree of latitude.

29 Food. The principal food of the whale is a ſpecies of *helix* and different ſpecies of actiniæ. It is not a little ſurpriſing that the whale of ſuch immenſe ſize, ſhould feed on ſuch ſmall animals, and ſhould acquire ſuch a quantity of fat as to yield above 150 tons of oil. But according to the teſtimony of thoſe employed in the whale fiſhery, theſe worms are found in ſuch abundance in the ſeas about Spitzbergen, that the whale has only to open his mouth to receive thouſands at once, and then rejecting the water through the fringe or beard attached to the jaws, theſe little animals remain behind, taken as it were in a net. And indeed, there ſeems to be a wiſe proviſion of nature for the ſubſiſtence of this monſtrous animal, in impreſſing on theſe worms and inſects, which are to be his food, a kind of inſtinct, which guides them to ſport about the fringes of the jaws, in the very gulf which is to ſwallow them up. Linnæus ſays that the whale alſo feeds on *meduſæ*. But to this it has been objected, that the meduſæ are not in ſufficient abundance in the northern ſeas, to furniſh the neceſſary quantity of food for ſo large an animal. It ſeems not improbable, however, that the meduſæ as well as the actiniæ may form part of its food.

The excrement of the whale has ſome degree of ſolidity, and it is of a yellow colour approaching ſomewhat to the colour of ſaffron.

30 Fiſhery by the Greenlanders. The whale fiſhery, or rather it might be termed the chaſe of the whale, conſtitutes one of the principal occupations of the inhabitants of Greenland. The capture of a ſingle whale is ſufficient for the ſubſiſtence of a whole family for a long time. The fleſh is eaten raw, baked, or after being half rotten, or dried in the heat of the ſun; and according to Horrebow, it has a very good taſte. 31 Uſes. The ſkin, the tail, and the fins, undergo no kind of preparation; for it ſeems theſe parts furniſh in the raw ſtate, a very delicate morſel to the Greenlanders. The fat is either eaten, or burnt for the purpoſe of giving light. The inteſtines are employed to ſhut up the doors and windows of their habitations; and the tendons furniſh thread for ſewing, or for the conſtruction of nets. Of the bones the Greenlanders make ſtools or chairs, and inſtruments that are uſed in hunting and fiſhing. The beſt lines are made of the hair that terminates the horny plates of the upper jaw.

The following are the dimenſions of a whale taken towards the north pole, and recorded by M. de Pages in the account of his voyage round the world.

	Feet.	Inches.
Total length,	48	0
Circumference of the head, which is the thickeſt part of the body,	26	0
Length of the head about	18	0
Length of the jaw-bones,	18	0
Diameter of the orbit of the eyes,	0	3
Opening of the eye-lids,	0	5
Diſtance of the eyes from the opening of the breathing holes,	6	0
Length of the cavity which includes the penis,	4	0
Depth of this cavity,	0	8
Diſtance of this cavity from the anus,	1	0
Diameter of each mamma,	0	6
Length of the papilla,	0	2
Diameter of it	0	1½
Diſtance of the two lobes of the tail fin, about	17	0
Depth of the hollow which ſeparates the two lobes,	2	6
Length of the lateral fins,	8	0
Breadth of the ſame, about	7	0

2. BALÆNA GLACIALIS, *Iceland Whale.*

French, *Le Nord Caper*, *Baleine de Sarde*; German, *Nordkaper*; Norwegian, *Sildqual*, *Nordkaper*.

32 Specific characters. In this ſpecies, the jaws are nearly of equal length. The under jaw is rounded, and broader towards the middle of its length. There is no dorſal fin. The back is whitiſh.

33 Body. The Iceland whale differs from the former only in the colour and dimenſions of the body. The head and horny laminæ of the upper jaw are much ſmaller. The trunk of the body is more ſlender, and is of a

light brown colour. It has been obſerved, that the lower jaw of this ſpecies is more elongated and rounder than that of the common whale.

34 Mode of taking by the Icelanders. As it is very dangerous to harpoon this ſpecies of whale, on account of its extreme agility, it is mentioned by Anderſon, that the Icelanders have a very ingenious method of taking it. When they perceive the whale in chaſe of the herrings, they inſtantly launch their canoes furniſhed with harpoons, ſpears, and knives, and endeavour to get between the whale and ocean. They continue the purſuit by rowing, and approach as near as poſſible. If the wind blow towards the ſhore, they pour on the ſea, a quantity of blood, with which they are always provided, and as it is carried by the waves to the coaſt, they endeavour to direct it as near to the ſhore as they can. The whale perceiving himſelf purſued attempts to regain the ocean, but when he approaches the blood he is alarmed, and rather than ſwim acroſs it, he makes his eſcape to the ſhores, where he often throws himſelf on the rocks. But if the wind blow from the land, the fiſhermen endeavour to get between the whale and the ocean, as in the other caſe; and when he attempts to make for the deep, they throw ſtones from their canoes, and ſhout and make a noiſe, ſo that the whale is terrified and is driven on ſhore. This, however, is contradicted by Horrebow, who remained two years in Iceland, and had good opportunities of being well informed of every thing relating to the whale-fiſhery. He ſays, that the Icelanders are neither hardy enough to make this hazardous attempt, nor ſo fortunate or dexterous as to take the whale ſo eaſily. The only method which is practiſed there, he ſays, is the following: When the boat approaches the whale, the harpooner diſcharges his harpoon, and the boat inſtantly retreats. The harpoon is known by having the mark of the proprietor, and when the whale has been ſucceſsfully wounded, he dies and is thrown aſhore. A certain portion belongs to the perſon who was ſo fortunate as to inflict the wound, and the remainder is claimed, according to a law of the country, as the right of the perſon on whoſe property he lands. According to this author, this is the whole art practiſed by the inhabitants of Iceland in the whale-fiſhery.

The Iceland whale yields only from 10 to 30 tons of blubber.—The food of this whale conſiſts of ſome ſpecies of *helix*, *meduſæ*, and herrings.

This whale inhabits the northern ocean, about the coaſts of Norway and Iceland.

Klein has made two varieties of this whale, diſtinguiſhing them by names derived from that part of the ocean where they are found. 1. Var. *Auſtralis*, which is found in the ſouthern ocean, has the back very flat. 2. Var. *Occidentalis*, found in the weſtern ocean, which has the back more elevated. The ſame naturaliſt has diſtinguiſhed the *Balæna glacialis* by the name *borealis*.

** *Species which have a Fin or Bunches on the Back.*

3. Balæna Physalus, or *Fin-Fiſh.*

French, *Le Gibbar*; German, *Finnfiſch*; Dutch, *Vinviſch*; Norwegian, *Ror-hual*, *Finne-fiſk*; Greenland, *Tummilik*; Iceland, *Hunſubaks.*

35 Characters. The jaws are equal and pointed; the horny laminæ of the upper jaw are ſhort, and of a bluiſh colour. There is one fin on the back.

36 Deſcription. According to the fiſhermen, the fin-fiſh is as long but not ſo thick as the common whale. When the jaws are ſhut, the head reſembles a cone, which conſtitutes nearly one-third part of the whole length of the whale, and terminates in a ſharp ſnout. On the top of the head are two reſpiratory orifices divided longitudinally. This whale, it is ſaid, ejects the water with much greater force than the common whale. The horny laminæ of the upper jaw are fringed and diſpoſed in the ſame manner as thoſe of the preceding. They differ in being ſhorter, and of a blue colour. The length is from 10 to 12 inches. The long hair which terminates the laminæ, is ſo twiſted that the edges of the upper jaw ſeem covered with a thick cord interwoven together. The eyes are placed very low, nearly in the direction of the angles of the mouth. Towards the poſterior extremity of the back, there ariſes a triangular fin, about 3 or 4 feet high, having the ſummit bent backwards. The lateral fins are of an oval figure, from 6 or 7 feet long. The tail-fin is divided into two lobes which form nearly a right angle.

37 Food. This ſpecies lives on the herring, the mackerel, a kind of ſalmon frequent in the northern ſea, and other ſmall fiſh.

The upper part of the body is of a ſhining brown colour. The belly and the under part of the lower jaw are of a ſplendid white.

This ſpecies of whale is found in the Greenland ſeas, in the European ſeas, in the Indian ocean, and in the new world. In March 1673, Martens mentions that he ſaw a whale of this ſpecies in the Straits of Gibraltar. As the maſs of the body conſtitutes the third or the fourth of that of the common whale, the fat is leſs thick. It yields, it is ſaid, only ten tons of oil. This whale is therefore leſs an object of the fiſherman's purſuit, for the produce of oil is not equivalent to the expence, the riſk, and the danger that attend it.

It has been remarked, that as ſoon as the fin-fiſh makes its appearance in the ſeas round Spitzbergen, the common whale is no longer to be ſeen.

38 Uſes. In Greenland the fleſh, the fins, the ſkin, and the tendons, are employed as food by the poorer inhabitants; and the bones are applied to a great many domeſtic uſes. It is ſaid that the fleſh has the ſame taſte as that of the ſturgeon.

4. Balæna Nodosa, the *Bunch* or *Humpback Whale.*

French, *Baleine-tampon*; German, *Plock-fiſh*; Dutch, *Pen-fiſh.*

39 Characters. The lateral fins are white. There is a bunch near the tail larger than the head of a man.

40 Deſcription. Of this ſpecies leſs is known than of the others. In place of the dorſal fin, there is a bunch near the tail which declines poſteriorly. It is about a foot high, and a little thicker than the human head. The lateral fins are white, placed near the middle of the body, and are 18 feet long. The blubber of the bunch-whale reſembles that of the fin-fiſh. According to Klein, the beard of this ſpecies is not held in much eſtimation, though it is more valued than that of the latter ſpecies. It is a native of the ſeas of new England.

5. Balæna Gibboſa, the *Scrag-whale*.

French, *La Baleine à ſix boſſes*; German, *Knotenfiſch*; Dutch, *Knobbelfiſch*.

41 Characters. The horny laminæ of the upper jaw in this ſpecies are white; and there are ſix bunches on the back.

42 Deſcription. In external form this ſpecies reſembles the common whale. It is nearly of the ſame colour, and yields an equal quantity of blubber. It ſeems difficult to reconcile this with the ſpecific name given by Klein, viz. *Balæna macra*, or lean whale. But it has been ſuppoſed that this refers to the muſcular parts, which are of ſmaller ſize.

The dorſal fin is wanting. Its place ſeems to be ſupplied by ſix bunches or knots towards the tail. The laminæ are white, and are found to ſplit with much difficulty.

Like the former, it inhabits the ſeas of New England.

*** *Species which have a Protuberance in form of a Fin on the Tail, and Folds on the Belly.*

6. Balæna Boops, the *Pike-headed Whale*.

French, *La Jubarte*; Greenland, *Keporkak*; Iceland, *Hrafin*, *Reydus*.

43 Characters. The lower jaw is a little ſhorter and narrower than the upper. The protuberance on the back is curved and ſtretching to the tail.

44 Deſcription. M. O. Fabricius, who was preſent and aſſiſted at the capture of a whale of this ſpecies, has given the following deſcription of it. The body is round and very thick near the lateral fins. It gradually diminiſhes to the end of the tail, the thickneſs of which is not greater than what a man can embrace. The head is oblong, inclining, and terminates in a broad obtuſe ſnout. Towards the middle of the head is the protuberance, in the middle of which are the two reſpiratory orifices, which are ſo cloſe to each other as to appear to be only one. Before the orifices there are three rows of circular protuberances, of which the uſe is not known. The lower jaw is ſhorter and narrower than the upper. The eyes are placed on the ſides of the head behind the orifices. The external opening of the organ of hearing forms two holes immediately behind the orbits of the eyes, but are almoſt imperceptible. The horny laminæ of the upper jaw are black, and ſcarcely a foot in length. They are diſpoſed in the ſame manner as in the common whale, but the interſtices in the fore part of the jaw are not filled up with ſmall laminæ. The tongue is large, fat, and ſpongy; its colour reſembles that of the liver. It is covered with a looſe ſkin, which ſtretches towards the gullet, where it forms a kind of operculum or covering.

The lateral fins are large, oval, interiorly entire, rounded, and notched poſteriorly, and a little hollowed externally. The tail fin is hollowed or notched in form of a creſcent, and terminates in a point. From the lower part of the mouth to the region of the anus, the inferior ſurface of the body is marked with folds or furrows which unite in pairs, and form angles at the two extremities. The two external furrows are always of the greateſt length; and it would appear that the whale has the power of dilating and contracting them at pleaſure.

The colour of the upper part of the body is black; the lower part of the mouth and the lateral fins are white; the cavity of the furrows is of a blood red; the interior folds, the belly, and the tail fin, are marked with black and white ſpots. Under the epidermis is the ſkin which covers the fat, which in this ſpecies is but a thin layer, and conſequently yields leſs oil than the preceding.

When the pike-headed whale takes in food, it opens its capacious mouth, and ſwallows a great quantity of water along with its prey. It is then that the folds of the ſkin on the belly are obſerved to dilate conſiderably; and then too the contraſt between the fine red in the cavity of the furrows, the black colour of the laminæ of the jaw, and the bright white on the under part of the mouth, produces a very ſtriking effect.

At every attempt at progreſſive motion, this ſpecies ejects the water by the reſpiratory orifices, but with leſs violence than other whales. The moment after, it diſappears under the water. And when it plunges and ſhews the tail-fin, it is conſidered as a ſign that it is going to deſcend to a great depth, and that it will remain a longer time under the ſurface. When the ſea is calm, it is ſeen aſleep on the ſurface of the water; and the moment it awakes, it performs a number of different motions with inconceivable rapidity. Sometimes it lies on its ſide; in an inſtant it ſtrikes the water with the lateral fins with prodigious force, and then turns on its back. It ſprings up into the air, and returns to the water in a whirling motion, at a conſiderable diſtance from the place from which it aroſe.

45 Food. The food of the pike headed whale conſiſts of a ſpecies of *helix*, a ſmall ſpecies of ſalmon which frequents the northern ocean, and the ſand-eel. It has only a ſingle young one at a time. The young whale follows its mother, till another is brought forth; but this does not happen every year.

The ſlighteſt wound is obſerved to occaſion the death of this ſpecies of whale; for the wound very ſoon runs into gangrene. The animal often goes to a great diſtance from the ſpot where it received the fatal blow. The ſureſt method ſeems to be to ſtrike with the ſpear immediately behind the lateral fins; and if it happen that the inteſtines are wounded, the whale inſtantly plunges into the ocean.

This ſpecies frequents chiefly the Greenland ſeas, between the 61ſt and 65th degree of latitude. In winter it appears only in the open ſeas, but in ſummer it approaches the ſhores, and enters the great bays.

The length varies from 50 to 54 feet. Sibbald has given a deſcription of a young one which was thrown aſhore on the coaſt of Scotland. The following are the dimenſions of the principal parts of the body.

	Feet.	Inches.
From the end of the ſnout to the extremity of the tail,	46	0
The greateſt thickneſs at the lateral fins,	20	0
The greateſt thickneſs at the dorſal fin,	12	0
Greateſt breadth of the lower jaw,	4	6
Length of the opening of the mouth,	10	0

	Feet.	Inches.
Breadth of ditto,	4	0
Length of the tongue,	5	0
Breadth of this organ at the root,	3	0
Length of the pectoral fins,	5	0
Breadth of ditto,	1	6
Breadth of the tail fin,	9	6
Length of the penis,	2	0

7. Balæna Musculus, the *Round lipped Whale.*

French and Greenland, *Rorqual;* Iceland, *Steipe, Reydus.*

46 Characters. In this ſpecies the lower jaw is longeſt and broadeſt. The protuberance on the back is ſtraight, triangular, and ſtretches to the tail.

47 Deſcription. This ſpecies reſembles the preceding in the form of the body. In both there is a prodigious enlargement of the ſide of the head, which gradually diminiſhes towards the tail. The ſtructure of the lower jaw furniſhes the principal characteriſtic diſtinction. In the pike-headed whale it is pointed; but in this ſpecies it is rounded, which gives the head an obtuſe ſhape. The opening of the mouth is ſo wide, that it will admit fourteen men ſtanding upright at the ſame time. The upper jaw is narrower than the lower; it is alſo more pointed at the extremity, and is received into the lower jaw. The tongue is compoſed of a ſoft ſpongy ſubſtance; and is covered with a fine membrane or ſkin. At the baſe of the tongue, on each ſide, there is a fleſhy maſs of a red colour, which ſhuts up the entrance of the gullet ſo cloſely that only ſmall fiſh can be admitted. The whole palate is covered with black laminæ, which terminate at their extremity in a ſilky hair which hangs over the tongue. The laminæ and the hair are of unequal length and breadth. Thoſe which are attached to the anterior part of the jaw are 3 feet long, and 12 inches broad; while thoſe near the entrance to the gullet are ſcarcely ſix inches long by one inch broad.

The eyes are placed above the angle of the mouth; they reſemble thoſe of the ox. Above the eyes, in the middle of the head, are ſituated the two reſpiratory orifices, which are of a pyramidal form.

The pectoral fins are large, a little oval, and tapering; and ſituated oppoſite to the angle of the mouth. The dorſal fin is placed directly oppoſite to the opening of the anus. It tapers a little, and is curved backward. The tail fin is divided into two lobes, which are curved like a ſcythe, and end in a point.

From the end of the lower jaw to the navel, the under part of the body is covered with rugæ or folds, which is two inches broad, having the cavities by which they are ſeparated of the ſame breadth. The ſides are covered with a layer of fat or blubber, 4 inches thick; and on the head and neck, where the fat is more abundant, it is a foot in thickneſs. The upper part of the body is black, the belly is white.

48 Food. The herring is the food of this ſpecies of whale

In the month of Septemper 1692, a whale of this ſpecies was thrown aſhore on the coaſt of Scotland, as we find it recorded by Sibbald. For twenty years before the fiſhermen had obſerved it occaſionally in purſuit of the herrings; and they recogniſed it in conſequence of a wound which it had received from a muſket. The ball had pierced through the dorſal fin. The following are the principal dimenſions, by the ſame author

	Feet.	Inches.
Whole length of the body, from the ſnout to the extremity of the tail,	78	0
Circumference of the body at its greateſt thickneſs,	35	0
Length of the lower jaw,	13	2
Length of the tongue,	15	7
Breadth of ditto,	15	0
Length of the pectoral fins,	10	0
Greateſt breadth of ditto,	2	6
Length of the dorſal fin,	3	0
Height of ditto,	2	0
Diſtance between the extremity of the lobes of the tail,	18	6
Length of the penis,	5	0

8. Balæna Rostrata, the *Piked Whale.*

French, *La Baleine à Bec.*

49 Characters. The jaws are long, narrow, and pointed, the lower jaw is longeſt. The protuberance which is placed on the extremity of the back, is roundiſh at the apex.

50 Deſcription. A ſide view of this ſpecis of whale preſents a lengthened oval form, which has the greateſt tranſverſe diameter towards the middle of the body. The head conſtitutes a fourth part of the length of the body, and is of a conical form. The jaws are larger, narrower, and more pointed than in the other ſpecies. The upper jaw is the ſhorteſt. The eyes are placed a little above the angles of the mouth, and the blowholes are on the top of the head. The laminæ of the upper jaw, according to Fabricius, are white and very ſhort.

The lateral fins occupy the middle of the height of the ſides; they are broad, nearly oval, and rounded. The dorſal fin is oppoſite to the anus. It is rounded at the top, inclining towards the tail. The tail fin is divided into two lobes which form by their junction a creſcent, the horns of which are directed behind.

The under part of the body, from the point of the lower jaw to the middle of the trunk, is covered with rugæ or folds in parallel rows, which ſtretch on both ſides to the inſertion of the pectoral fins. The back is black; but this gradually diminiſhes towards the belly, which is pure white, varied with a mixture of reddiſh ſhades.

This ſpecies of whale ſwims with extraordinary velocity. The fat or blubber is very compact, and yields but a ſmall quantity of oil. The fiſhermen are therefore not very eager in the purſuit of it. But as the inhabitants of Greenland conſider the fleſh very delicate food, they are often employed in taking this whale. They never approach ſo near as to ſtrike it with the harpoon; but diſcharge arrows from a diſtance, the wounds of which almoſt always prove mortal.

51 Food. The food of this whale is the ſame as of ſome of the other ſpecies; chiefly, the ſmall ſpecies of ſalmon of the northern ſeas, and the other ſmall fiſh, which it purſues with ſuch avidity, that they are often ſeen leaping from the ſea to avoid the purſuit. This is the ſmalleſt ſpecies of whale.

52 Where found. It is found moſt frequently in the Greenland ſeas; and often alſo in the European. One which was taken on the Dogger bank, meaſured 17 feet in length. It had loſt the dorſal fin, and by ſome other accident the jaws were ſo ſwelled, that the head formed a maſs ſpecifically lighter than water, and therefore did not ſink in that element.

CLASS II. MONODON.

Genus 1ſt. MONODON, *Unicorn-fiſh*, or *Sea-Unicorn*.

53 Generic Characters. The body is naked, oval, oblong, round and ſpotted. The head is ſmall, and not eaſily diſtinguiſhed from the reſt of the body. There is only one reſpiratory orifice, which is placed on the top of the head, and ſhut up by a covering cut in form of a comb. The opening of the mouth is ſmall. There are no teeth in the mouth; but from the upper jaw there proceeds, inclining ſometimes to the right ſide, and ſometimes to the left, one long tooth which is twiſted in a ſpiral form. There are rarely two; but when that is the caſe, they are nearly of the ſame length; and there is only one ſpecies which has the teeth curved at the extremity. The eyes and ears are very ſmall. The penis of the male is encloſed in a kind of ſheath; and the female has two mammæ on the belly, between which are the organs of generation.

There are three or four fleſhy fins; two pectoral fins; one at the extremity of the tail; and that of the back is often replaced by a projection which runs its whole length.

SPECIES.

Plate CXL. fig. 2. 1. MONODON MONOCEROS, the *Narhwal*, or *Unicorn-Fiſh*.

French, *Narhwal, Licorne de mer;* Norwegian, *Lighval;* Iceland, *Narhwal;* Greenland, *Tauvar.*

54 Characters. One tooth in ſhape of a horn, inſerted in the upper jaw, and ſpirally twiſted; there are rarely two.

There is no tail fin.

55 Deſcription. The body of the narhwal is oblong and oval; the back broad, convex, and tapering towards the tail; the head is round, ſmall, enlarged at the top, and terminates in an obtuſe rounded ſnout. There are no teeth; but a long twiſted tooth, which is attached to the upper jaw. It was long ſuppoſed that this bony inſtrument of defence was the horn of a very rare quadruped, and conſequently it was ſold at a very high price. Each tooth is from nine to ten feet in length, and poſſeſſes ſome of the properties of ivory. It is however eaſy to diſtinguiſh them. The fibres of the tooth of the unicorn-fiſh are finer than ivory; it is more compact, heavier, and leſs apt to become yellow. The narhwal is rarely furniſhed with more than one tooth, but under the common ſkin of the head on the other ſide, the rudiments of another may be obſerved. There have been, however, different examples of two teeth, and both nearly of the ſame length. In the year 1604, a female having two teeth was taken, and the bones of the head, with the teeth inſerted, were brought to Hamburgh. The two teeth proceeded in a right line from the anterior part of the ſkull. At the place of inſertion they were only two inches aſunder, but gradually diverging, they were ſeparated at the extremity 18 inches. The left tooth was 9 inches in circumference, and 7 feet 5 inches long. The right was ſeven feet long, and eight inches in circumference at the baſe. Both teeth entered 13 inches into the bones of the head, which was two feet long, and 18 inches broad.

The opening of the mouth is in general very ſmall; not larger, according to ſome, than to admit the hand of a man. The tongue is nearly of the ſame ſize. The head ends in a rounded ſnout. The lower lip is thin, and ſhorter than the upper.

The eyes are placed oppoſite to the opening of the mouth; and they are ſurrounded by a kind of eye lid. On the top of the head there is one reſpiratory orifice, which may be ſhut and opened at pleaſure by means of a fringed covering.

The pectoral fins are about a foot long, and eight inches broad. The fin of the tail is divided into two obtuſe oval lobes. In place of the dorſal fin, there is a ridge or projection about nine inches high, which extends from the breathing hole on the head to the baſe of the fin, which terminates the trunk of the body, and diminiſhes gradually in height as it approaches to the tail.

The ſkin is about one inch in thickneſs. The colour is of a greyiſh white, marked with a great number of black ſpots which ſeem to penetrate the ſubſtance of the ſkin. The ſkin of the belly is of a ſhining white, and ſoft as velvet to the touch.

The oil which the unicorn-fiſh yields is in ſmall quantity, but it is conſidered to be of a ſuperior quality to that of the Greenland or common whale. The food of this fiſh is one of the ſpecies of the *Pleuronectes*, and ſome ſpecies of *helix*. 56 Food.

The length of the unicorn-fiſh is from 20 to 22 feet, the circumference about 12 feet. According to ſome authors indeed, ſome fiſh have been found 60 feet long. It inhabits chiefly the northern ſeas of Europe and America, about Davis ſtraits, and the coaſts of Iceland.

It would be difficult to take this fiſh ſingly and in the open ſea; for they are excellent ſwimmers, move with aſtoniſhing velocity by means of the tail-fin. But as they live in very cold climates, and cannot remain long under water without reſpiring, they frequent the bays that are free of ice. In theſe places they crowd together in ſuch numbers, that they force their teeth into the body of each other; and in this ſituation they can neither plunge into the deep water, nor avoid the purſuit and blows of the fiſhermen.

57 Uſes. There is no part of this fiſh which is not applied to ſome uſeful purpoſe by the inhabitants of Greenland. They are extremely fond of the fleſh, which they eat roaſted or dried in the ſmoke. The inteſtines alſo are regarded as a very delicate food. They are alſo roaſted. The fat affords an oil for burning. From the gullet they obtain bags or bladders which they employ in fiſhing. The tendons are made into excellent thread or ſmall cords. Of the teeth they make ſeveral inſtruments which are uſed in the chaſe, or ſtakes for the conſtruction of their huts.

58 Magnificent throne of the teeth. The kings of Denmark have a moſt magnificent throne which is entirely compoſed of the teeth of the unicorn-fiſh. It is preſerved in the caſtle of Roſenberg; and it is eſteemed of greater value than if it were made of gold.

It has been affirmed by ſome naturaliſts, that there have been found individuals of the unicorn fiſh having protuberances on the back, and that in others the teeth were not ſpirally twiſted, but ſmooth from the baſe to the extremity. Should theſe differences turn out to be uniform and conſtant, other ſpecies beſide thoſe already known muſt be admitted.

2. Monodon Spurius, the *Spurious Narwhal* or *Unicorn fiſh*.

French, *L'Anarnak*.

59 Characters. In this ſpecies there are two ſmall curved teeth in the upper jaw, and one fin on the back.

60 Deſcription. This ſpecies, which has been deſcribed by Fabricius in his *Fauna Groenlandica*, properly belongs to the genus Monodon, at leaſt the characters correſpond more nearly to this genus than any other. The body is oblong, rounded, and of a black colour. There are no teeth in the mouth; but to the upper jaw are attached two ſmall teeth which are of a conical form, a little curved at the extremity, and about one inch long. Beſide the two pectoral fins, there is a ſmall one on the back.

This ſpecies is one of the ſmalleſt fiſhes belonging to this claſs. It reſpires like the other cetaceous fiſhes by a breathing hole on the top of the head.

It rarely happens that the tail fin is ſeen when it plunges into the water, but when it reſpires the air it riſes above the ſurface of the ſea as high as the inſertion of the pectoral fins.

The fleſh and fat are found to have a violently purgative effect. From this property the Greenlanders have given it the name *Anarnak*, which is adopted by the French naturaliſts.

It inhabits chiefly the open ſea, and very rarely approaches the ſhores. It is moſt commonly found in the Greenland ſeas.

Class III. PHYSETER.

Genus 1ſt, Physeter. *Spermaceti Whale*.

61 Generic characters. The body is naked, ſometimes oval, and ſometimes in the form of a lengthened cone. The head is very thick, anteriorly truncated, and occupying nearly one half or one third of the whole length of the body. There is only one breathing hole, which is placed on the ſnout. The jaws are unequal. The lower is ſhorter and narrower, and it is furniſhed with teeth which are ſometimes of a conical form, and ſometimes blunt; ſometimes ſtraight, but often curved in form of a ſickle. In the upper jaw there are correſponding cavities. It is alſo furniſhed with teeth, but they are flat, lie horizontally, and are ſcarcely viſible.

The eyes are ſmall, and are ſituated near the inſertion of the pectoral fins. The external opening of the organ of hearing is very ſmall, and not eaſily detected.

The penis, as in the other claſſes, is included in a ſheath. The female has two mammæ ſituated in the abdomen, and between them are placed the parts of generation, near which is the external opening of the anus.

There are three fleſhy fins. Two of theſe are the pectoral; and the third is at the extremity of the tail. The place of the dorſal fin is occupied by a falſe fin, and often by a kind of calloſity.

Species.

1. Physeter Macrocephalus, the *Large Spermaceti Whale*.

French, *Cachalot*; Germ. *Pottfiſch*; Dutch, *Potviſch*; Norweg. *Kaſkelot*, *Potfiſk*, *Trold*, *Hual*. Plate CLX. fig. 3.

62 Characters. There is a ſpurious fin on the back. The teeth are curved, and a little pointed at the extremity.

63 Deſcription. Of all the ſpecies belonging to this genus, this, on account of its great bulk, is entitled to the firſt place. The head, which occupies the third part of the body, is a large maſs of a ſquare form, angular at the ſides, and truncated before. The upper is of much greater length than the lower. It is alſo broader, its edges forming a very conſiderable projection, and folded back towards the centre, where there is an oval longitudinal cavity deſtined to receive the lower jaw. The lower jaw is furniſhed on each ſide with a row of ſtrong conical teeth, a little curved towards the mouth, and projecting from the alveolar proceſs about one and a half inches. The two teeth at the anterior extremity of the jaw, and the four which terminate on each ſide the two rows, are ſmaller and more pointed. The colour of them externally approaches to that of ivory; but internally they are leſs hard and compact, and are of an aſh colour. It has been ſuppoſed that the teeth become longer, thicker, and more curved, in proportion to the age of the animal. The ordinary length is about ſix inches, and three inches in circumference at the baſe. The upper jaw is furniſhed with as many cavities as there are teeth in the lower jaw; but, in the interſtices which ſeparate theſe cavities, there are about 20 ſmall teeth placed horizontally, and raiſed a little above the fleſh. Theſe teeth are ſharp on the ſide oppoſite to the place of inſertion, but preſent a ſmooth, plain, and oblique ſurface, which fills up the interval that ſeparates the cavities. This oblique ſurface is only viſible; the reſt of the tooth is covered with fleſh. And from not attending to the form and diſpoſition of theſe teeth, it has been generally ſaid that the ſpermaceti whale had none in the upper jaw.

The tongue is a maſs of fleſh of a ſquare form, and of a livid red colour, which fills almoſt the whole of the bottom of the mouth.

The breathing holes, paſſing diagonally through the head, unite into one at the ſuperior extremity of the ſnout, where the opening is about ſix inches diameter.

The eyes are black, very ſmall when compared to the bulk of the body, and ſurrounded with a ſtrong ſhort hair, which is not very perceptible. The opening of the ears is not eaſily detected. It is placed behind the orbit of the eyes, on a cutaneous excreſcence between the eyes and the pectoral fins.

The head is ſeparated from the trunk by a tranſverſe groove, which extends to the place of inſertion of the pectoral fins. Theſe fins are of an oval form, three or four feet long, and three inches thick.

On the back there is a calloſity which extends two-thirds of the whole length. It riſes ſeveral inches above the ſurface, and is ſlightly inclined. Where it terminates behind it is truncated.

The organs of generation reſemble thoſe of quadrupeds. The penis of the male is encloſed in a ſheath.

On each ſide of the ſame organs in the female are placed the mammæ, which are four or five inches long.

The tail, which is ſmall for the ſize of the fiſh, terminates in a fin, which is divided into two lobes, hollowed out in form of a ſickle.

The back is black, or of a ſlate blue ſpotted with white. The belly is alſo white. The fat or blubber, which lies immediately under the ſkin, is about five or ſix inches thick on the back, and rather leſs on the belly. The fleſh is of a pale red, like that of pork. The head, though very large, is the leaſt fleſhy part of the body. But it yields the ſubſtance called *ſpermaceti*, in great abundance. This ſeems to vary in colour according to the climate in which the whale has lived.

The food of the ſpermaceti whale is the dog-fiſh and the lump fiſh.

This whale ſwims with great velocity; and he often appears on the ſurface of the water. It is at this time that the fiſhermen take the opportunity of ſtriking him with their ſpears; and it often happens, that the parts of the body which have been wounded become gangrenous, and fall off before the death of the animal.

The fleſh, the ſkin, the fat, and the inteſtines, are applied to the ſame purpoſes as thoſe of the unicorn-fiſh. The tongue, roaſted, is reckoned excellent food; and of the different bones of the body beſide the teeth inſtruments for the chaſe are made.

This whale inhabits chiefly the Greenland ſeas and Davis ſtraits; but occaſionally is found on the European ſhores to the ſouthward. In the year 1784, in the month of March, 31 of theſe fiſhes came on ſhore on the weſtern coaſt of Andierne in Lower Brittany in France. The following are the dimenſions of one of theſe taken at the time.

	Feet	Inches.
Total length,	44	6
From the anterior extremity of the ſnout to the eyes,	8	0
From the eyes to the pectoral fins,	3	0
From the pectoral fins to the organs of generation,	19	7
Length of the tail,	6	9
Diſtance of the lobes of the tail,	10	0
Circumference at the greateſt thickneſs,	34	8
Length of the upper jaw,	5	0
——— ——— lower jaw,	4	6
Opening of the mouth,	3	10
Breadth of the ſnout,	5	0

2. Physeter Catodon, the *Small Permaceti Whale.*

French, *Le Petit Cachalot*; Norwegian, *Swine, Hual*; Greenland, *Kegutilik*.

64 Characters. In this ſpecies, there is a rough ſpurious fin on the back. The teeth are curved and blunt.

65 Deſcription Without attending to the form and diſpoſition of the teeth in the cetaceous fiſhes, the characteriſtic marks are often ambiguous. All naturaliſts agree, that the characters taken from the teeth are the moſt certain, becauſe they are moſt conſtant and uniform in ſtructure and appearance, and leſs ſubject to thoſe variations which age and climate ſeem to produce. This ſpecies is, in this manner, eaſily diſtinguiſhed from the others. The head is of a round form; the opening of the mouth is of moderate ſize; the lower jaw is longer, but not ſo broad as the upper. It is furniſhed with a row of teeth on each ſide; and theſe correſpond to the cavities in the upper jaw, which receive them. There is a peculiar ſtructure of the teeth in this ſpecies. That part of the tooth which riſes above the gum has a greater thickneſs than where it is inſerted into the jaw; and beſides, each tooth is flat at the top, and marked with concentric lines. The longeſt teeth are two inches in length, and about an inch in circumference at the greateſt thickneſs.

Sibbald has miſtaken the breathing hole for noſtrils; and this ſeems to have ariſen from the poſition of the breathing holes near the ſnout of the fiſh.

This ſpecies is chiefly an inhabitant of the northern ſeas.

Towards the end of the 17th century, 102 of this ſpecies came on ſhore at Cairſton in the Orkney iſlands. The longeſt was 24 feet.

3. Physeter Trumpo, the *Spermaceti Whale.*

French, *Le Cachalot de la Nouvelle Angleterre; Le Trumpo.*

66 Characters. This ſpecies is diſtinguiſhed by a bunch on the back, and having the head ſtraight and pointed.

67 Deſcription The head of this ſpecies is of an immenſe ſize. It divides the body nearly into two equal parts. The upper jaw is much longer and thicker than the lower, which is furniſhed with 18 teeth, ſtraight and pointed, about three inches diſtant from each other; and when the mouth is ſhut, they are received into cavities of the upper jaw.

The eyes are ſmall. The breathing hole is at leaſt a foot in diameter, and it is placed at the ſuperior extremity of the ſnout.

The thickeſt part of the body is near the inſertion of the pectoral fins. Theſe are very ſmall; and that of the tail is divided into two lobes. In place of the dorſal fin, there is a bunch on the back which is more than a foot thick. It is placed nearly oppoſite to the parts of generation.

The ſkin is of a grayiſh colour, and very ſoft to the touch. The length of this whale varies from 48 to 60 feet.

It is chiefly an inhabitant of the ſeas which waſh the ſhores of New England.

An individual of this ſpecies landed in the year 1741, near Bayonne in France. It yielded ten tons of ſpermaceti, which was reckoned of a ſuperior quality to that of the large ſpermaceti whale. In the ſtomach of the ſame whale was found a round maſs of ſeven pounds weight, which was taken for ambergreaſe.

68 Spermaceti. The ſubſtance called *ſpermaceti* is lodged in particular cells in the head near the ſeat of the brain. It is extracted by making a hole in the ſkull.

It has been obſerved by ſome naturaliſts, that this whale is more agile and more dangerous than any other of the ſpecies. When it is wounded, it is ſaid that it throws itſelf on its back, and defends itſelf with its mouth.

Mr Pennant has deſcribed this under the name of the *blunt-headed whale* (Phyſeter Microps, Lin.). But if we attend to the form of the body, the ſtructure of the head, the number and ſtructure of the teeth, it ſeems to conſtitute a diſtinct ſpecies.

Dimenſions of the Spermaceti Whale thrown aſhore near Bayonne.

	Feet.	Inches.
Total length,	49	0
Greateſt circumference at the eyes,	27	0
From the extremity of the tail fin to the opening of the anus,	14	0
Length of the penis,	4	0
——— ——— ſheath which encloſes it,	1	6
Diameter of the penis,	0	7
Diſtance of the extremities of the two lobes of the tail	13	0

4. PHYSETER CYLINDRICUS, the *Round Spermaceti Whale.*

69 Characters. There is a bunch on the back; the teeth are curved and pointed at the top; the breathing hole is in the middle of the ſnout.

70 Deſcription. The form and relative ſituation of the trunk and head, the poſition of the breathing-hole, the relative length of the jaws, the number and ſtructure of the teeth, and eſpecially the ſize of the dorſal fin, preſent differences which ſufficiently diſtinguiſh this from the following ſpecies. The body is cylindrical, from the extremity of the ſnout to a line drawn perpendicular to the place where the penis is inſerted, and from thence to the tail fin it gradually diminiſhes. The head is at leaſt the third of the whole length of the body. The profile of the head preſents a kind of parallelogram. The jaws are nearly of equal length. On each ſide of the lower jaw there is a row of 25 curved, ſharp-pointed teeth. The breathing-hole is placed at the ſuperior extremity of the ſnout. The dorſal fin is replaced by a bunch, 18 inches high, and four and a half inches long at the baſe. The tail fin is divided into two lobes, forming a kind of creſcent.

One of this ſpecies is deſcribed by Anderſon, which was 48 feet long, 12 of perpendicular height, and 36 in circumference, at its greateſt thickneſs.

5. PHYSETER MICROPS, the *Black-headed Spermaceti Whale* or *Cachalot.*

French, *Cachalot Microps*, *Cachalot à dents en Faucille:* Norwegian, *Staur-Hyming;* Greenland, *Tifaguſik.*

71 Characters. In this ſpecies there is a long ſtraight fin on the back. The teeth are curved, the point is at firſt directed to the mouth, and then turns outwards.

72 Deſcription. The deſcriptions of naturaliſts who have treated of this ſpecies of whale are greatly confuſed; and this probably ariſes from not having attended ſufficiently to the form of the teeth. According to Fabricius, there are only 22 teeth in the lower jaw, 11 on each ſide. All theſe teeth are curved, having the concave ſide towards the mouth, and are ſunk in the jaw-bone, two-thirds of their whole length. The external part of the teeth is white as ivory, of a conical form; and the point, which is ſharp, inclines a little outwardly. That part of the tooth which is ſunk in the jaw is compreſſed on two ſides, and furrowed on that ſide next to the gullet. The Greenlanders ſay that this whale has teeth in the upper jaw: but this is not clearly aſcertained. Perhaps they are only flatted teeth, ſimilar to what we have deſcribed in the great ſpermaceti whale. Each tooth extends to a finger length, and is about one and a half inch broad. The longeſt occupy the middle part of the jaw. The ſmaller are at the extremities. The ſnout ends in a blunt ſurface; and, according to moſt naturaliſts, the upper jaw is the longeſt.

The pectoral fins are about four feet long. What occupies the place of a fin on the back is of conſiderable height, and has been by ſome naturaliſts compared to a long needle.

This whale is the declared enemy of ſome of the other whales, as the pike-headed whale and the porpoiſe, which it purſues as its prey. In Greenland the fleſh of this whale is greatly eſteemed, even more than that of any of the other ſpecies. It is rarely taken with the harpoon.

It inhabits chiefly the northern ocean.

6. PHYSETER MULAR.

French, *Le Cachalot Mular.*

73 Characters. This ſpecies is diſtinguiſhed by a very elevated fin on the middle of the back. The teeth are ſlightly curved and obtuſe.

74 Deſcription. This ſpecies reſembles the former in the general ſtructure of the body. It differs in the form of the teeth, which are leſs curved, and are obtuſe. The longeſt, which are eight inches in length, and nine inches in circumference, occupy the front of the jaw. The others are only ſix inches long. Sometimes the teeth are found to be hollow, and ſometimes they are ſolid. Is this owing to the difference of age in the individuals in which it has been obſerved? Beſide the pectoral fins, that which is placed on the back is very remarkable on account of its length. Sibbald compares it to the mizzen maſt of a veſſel.

According to Anderſon, this ſpecies is farther diſtinguiſhed by having three bunches or protuberances towards the extremity of the back: the firſt is 18 inches high; the ſecond, ſix inches; and the laſt only three inches. The ſame hiſtorian has obſerved, that he was informed by the captain of a ſhip, that he ſaw on the coaſt of Greenland, a great number of this ſpecies of whale, at the head of which was one of 100 feet long, which ſeemed to be the leader; and which, at the appearance of the ſhip, gave ſuch a terrible ſhout, ſpouting water at the ſame time, as to ſhake the veſſel. At this ſignal, the whole made a precipitate retreat.

This ſpecies is gregarious, and frequents the ſeas about the North Cape. They are but rarely taken; for they are very wild and difficult to wound. It appears, that the harpoon can only pierce them in one or two places near the pectoral-fins.

The fat or blubber is very tendinous, and yields but a ſmall proportion of oil.

CLASS. IV. DELPHINUS.

Genus 1ſt, DELPHINUS, the *Dolphin.*

75 Generic characters. The body is naked, oval, or of an oblong conical ſhape, of a blue colour, inclining to black. The head is conical, diminiſhing gradually towards the ſnout.

The breathing-hole, which is on the top of the head, is in form of a creſcent, the horns of which are directed towards the ſnout. The jaws are of equal length, ſometimes beaked, and ſometimes rounded. They are furniſhed with teeth, which are conical or compreſſed, pointed or obtuſe, and in ſome ſpecies notched.

The eyes are placed near the angles of the mouth. The pupil of the eye is black, and the iris white. The external opening of the ears is ſituated behind the eyes. The noſtrils terminate in the ſnout.

The penis of the male is included in a ſheath; and the mammæ of the female are attached to the belly; and between them are the organs of generation.

There are four fins; two are pectoral; there is one on the back, and one at the extremity of the tail. In one ſpecies only the dorſal fin is wanting.

Species.

1. Delphinus Phocæna, the *Porpoiſe* or *Porpeſſe*.

French, *Le Marſouin*; Spaniſh, *Marſopa*; Dutch, *Bruinviſch*; German, *Meerſchwein*, *Braunfiſch*; Danes, *Marſwin*, *Tumler*; Norweg. *Niſe*; Greenland, *Niſa*.

76 Characters. The form of the body is conical. The dorſal fin is triangular. The ſnout is pointed. The teeth are enlarged at the ſummit, rounded and cutting.

77 Deſcription. The body of this fiſh is round, thick, and diminiſhes towards the tail. The head reſembles an obtuſe cone. It is ſwelled out towards the top above the orbits of the eyes. It then gradually diminiſhes, and ends in a ſharp ſnout.

The eyes are placed oppoſite to the opening of the mouth; and the pupil of the eye, which is black, is ſurrounded with a white iris. Behind the eyes there is a ſmall round hole, about one inch in diameter: This is the organ of hearing. The noſtrils are placed between the breathing hole and the extremity of the ſnout. The breathing-hole is ſituated on the top of the head, in a line perpendicular to the interval between the eyes and the angles of the mouth.

The pectoral fins are attached to the edges of the lower ſurface of the body. The dorſal fin is triangular, and is ſituated very nearly on the middle of the trunk. Directly under the dorſal fin on the belly are the parts of generation. The anus is ſituated at an equal diſtance between the parts of generation and the tail fin.

The length of the porpoiſe is from four feet to ſix and eight. This fiſh is an excellent ſwimmer. When it riſes to the ſurface to reſpire, the back only appears; the head and tail are kept under water. But when it is dead, it becomes ſtraight.

78 Food. It feeds on ſmall fiſhes, and purſues them with inconceivable rapidity.

79 Manners. The porpoiſe is generally gregarious; this is particularly the caſe in the time of copulation in the month of Auguſt. It is not unuſual to ſee at that time 15 males in purſuit of one female; and ſo eager are they in the chaſe, that they are often thrown aſhore. The female goes with young 10 months, and brings forth one at a time. At birth the young one is of conſiderable ſize, and it conſtantly follows the mother till it is weaned. When a pregnant female is killed, it has been obſerved that the tail of the fœtus is ſeen thruſt through the navel of the mother. This is ſuppoſed to be occaſioned by the ſpaſmodic contraction, produced by the efforts of the mother in the ſtruggles of death.

80 Uſes. The fleſh of the porpoiſe has a diſagreeable oily taſte. It is however uſed as food by the inhabitants of Lapland and of Greenland. In Greenland they ſuffer it to undergo ſome degree of putrefaction to make it tender, and then they prepare it by roaſting or boiling. They uſe the ſkin, the fat, and the entrails for this purpoſe. The Dutch and the Danes take the porpoiſe only for the extraction of the oil.

The porpoiſe inhabits thoſe places which are ſheltered by rocks and bays, and is oftener ſeen in ſummer than in winter.

2. Delphinus Delphis, the *Dolphin* or *Bottle-noſe Whale*.

French, *Dauphin*; German, *Meerſchwein*, *Tummler*; Dutch, *Dolphin Tuymelaar*; Norwegian, *Springer*; Iceland, *Leipter*.

81 Characters. The body is nearly oval. The dorſal fin is curved at the top. The ſnout is flattened and ſharp. The teeth are cylindrical and pointed.

82 Deſcription. The greateſt thickneſs of the dolphin is at the inſertion of the pectoral fins; from which the body gradually diminiſhes towards the head and tail, and thus has the oval form. The head enlarges at the top like that of the porpoiſe; but, in the dolphin, it diminiſhes in thickneſs, and ends in a flatted beak, like that of a gooſe. The jaws are of equal length, and furniſhed on each ſide with a row of cylindrical teeth, a little pointed at the end, and projecting near one and a half inches above the gum. It would appear that the number of teeth varies according to the age and ſex. Klein has reckoned 96 in the upper jaw, and 90 in the under. Mr Pennant, on the contrary, mentions that he ſaw 19 teeth in the latter, and 21 in the former. Forty-ſeven teeth have been obſerved by others in each jaw.

The eyes are placed almoſt in the ſame line with the opening of the mouth. The breathing-hole is on the top of the head, oppoſite to the orbit of the eyes. It appears in form of a creſcent, the horns of which are directed towards the ſnout.

The pectoral fins are oval, and inſerted at the under part of the breaſt. The dorſal fin occupies the middle of the body. It is curved backwards at the extremity. The tail fin is divided into two lobes, the one of which folds over the other.

The upper ſurface of the body is black; the breaſt is white. From under the eyes on each ſide paſſes a white ray, which ſtretches towards the pectoral fins.

The dolphin is almoſt always an inhabitant of the open ſeas, and very rarely approaches the ſhore. His motions are inconceivably ſwift; and hence he has been named by the mariners, the *arrow of the ſea*.

The length of the dolphin varies from five to nine or ten feet.

83 Fabulous hiſtory. The deſcription which has now been given, has little relation to the fanciful accounts which have been detailed of this fiſh, or to the imaginary repreſentations by the ancient painters and engravers. On the pieces of money which were in circulation in the time of Alexander the Great, and are preſerved by Belon, as well as on other medals, the dolphin is repreſented

with a very large head, a ſpacious open mouth, and the tail raiſed above the head,

No animal has been more celebrated by the ancient poets and hiſtorians than the dolphin. From the earlieſt ages he was conſidered as conſecrated to the gods, and honoured as the benefactor of man. Pliny, Ælian, and other ancient authors, ſpeak highly of his attachment to mankind. The younger Pliny has written a charming ſtory of the loves of a dolphin for Hippus; and Ovid relates with all the beauties of poetry, the ſtory of the muſician Arion, who being purſued by pirates and thrown into the ſea, was reſcued and ſaved by this kind animal.

> *Inde (fide majus) tergo delphina recurvo,*
> *Se memorant onere ſuppoſuiſſe novo.*
> *Ille ſedens citharamque tenet, pretiumque vehendi*
> *Cantat, et æquoreas carmine mulcet aquas.*
> *Di pia facta vident. Aſtris delphina recepit*
> *Jupiter; et ſtellas juſſit habere novem.*
> Ovid. Faſti, lib. ii. 117.

> But (paſt belief) a dolphin's arched back
> Preſerved Arion from his deſtined wreck;
> Secure he ſits, and with harmonious ſtrains
> Requites his bearer for his friendly pains.
> The gods approve: the dolphin heaven adorns,
> And with nine ſtars a conſtellation forms.

But after all theſe fabulous accounts of the dolphin by the ancients, and the preſages drawn by the modern ſailors from their movements, it does not appear that this ſpecies of fiſh is endowed with more ſagacity than any other of the cetaceous fiſhes, or diſcovers greater attachment to man. What may have been the foundation of theſe fables, it is not our preſent object to inquire. It is true, that the dolphin and others of the cetaceous fiſhes accompany ſhips for ſeveral days together. But this ſeems to be in ſearch of food, on account of the offals of animal matters that are thrown overboard.

3. Delphinus Tursio.

Greenland, *Neſarnak;* French, *Le Neſarnak.*

84 Characters. The form of the body is conical. The dorſal fin is curved. The ſnout is compreſſed above. The teeth are ſtraight and blunt.

85 Deſcription. The greateſt thickneſs of this ſpecies is between the dorſal and pectoral fins. From this to the extremity of the tail the body becomes gradually more ſlender.

The breathing hole, which is placed above the orbits of the eyes, is about 1½ inches in diameter. The anterior part of the head is inclined and rounded, and terminates in a flat beak. The lower jaw is the longeſt. Both jaws are furniſhed with 42 cylindrical teeth, which are diſpoſed in a ſingle row.

The pectoral fins are very low, and are of a falciform ſhape. The dorſal fin riſes like an inclined plane, and is incurvated behind. At the poſterior baſe of the latter fin there ariſes a projection which ſtretches to the tail. The tail fin is divided into two lobes in form of a creſcent.

The upper part of the body is black; the belly is white.

It has been obſerved by ſome naturaliſts, that when this ſpecies riſes to the ſurface to reſpire, a great part of the body appears above water. It inhabits the open ſeas, and is conſequently taken with difficulty. The fleſh, the fat, and the entrails, are eaten in the ſame way as the porpoiſe.

4. Dilphinus Orca, the *Grampus.*

Plate CXL. fig. 4.

French, *Epaulard;* Norwegian, *Spek-Hugger, Hoval-Hund;* Dutch, *Botſkop;* Iceland, *Huyding;* Swedes, *L'Opare.*

86 Characters. The body is nearly oval. The dorſal fin is very high. The teeth are conical and ſlightly curved.

87 Deſcription. The profile of the grampus is oval and oblong. The greateſt thickneſs is about the middle of the trunk, from which it gradually diminiſhes towards both extremities. The ſnout is ſhort and round. The lower jaw is broader than the upper. Both jaws are furniſhed with conical teeth, which are unequal and curved at the top, and are from 20 to 30 in number in each jaw.

The eyes are ſituated in the ſame line with the opening of the mouth.

But the moſt diſtinguiſhing mark of the grampus is the dorſal fin, which riſes from the middle of the back in the form of a cone, and is nearly four feet in height. The pectoral fins are very broad and nearly oval. The tail fin is divided into two lobes in the form of a creſcent. The penis is three feet in length.

The upper part of the body is black; the belly is white. Sometimes white ſpots are obſerved on the head and back.

The grampus is the largeſt fiſh belonging to the genus. Some have been ſeen of 25 feet in length by 12 or 13 in circumference. One of 24 feet long was taken in the mouth of the river Thames in the year 1759.

All naturaliſts agree in deſcribing the grampus as the moſt cruel and voracious of the family of the dolphin. Its ordinary food is the ſeal and ſome ſpecies of flat fiſh. But it is ſaid, that it will attack the porpoiſe, and even the large whale. The latter, ſo far from defending himſelf, is ſtruck with terror, utters dreadful ſhouts, and, to eſcape from the enemy, quits the open ſeas, and retires towards the coaſts, which is perhaps the reaſon that the whale is ſometimes thrown aſhore. The grampus, however, is often the victim of its voracity. It is at this time that the fiſhermen watch the opportunity of ſtriking him with the harpoon.

When the emperor Claudius was engaged in the conſtruction of the harbour of Oſtia, a grampus, attracted by ſome ſkins which had been ſunk in a ſhipwreck, came upon the coaſt. There he remained for ſeveral days; and, forming a kind of canal to receive his huge body in the ſand, was protected from the agitation of the ſea. While in purſuit of his prey one day, he was driven aſhore by the violence of the waves. The back appeared above the ſurface of the ſea, and reſembled a ſhip with its bottom upwards. The emperor cauſed ſtrong nets to be ſtretched acroſs the mouth of the harbour to prevent the eſcape of the fiſh, in caſe he ſhould again get into the water. He then advanced in perſon, accompanied with his pretorian bands, and exhibited a very amuſing ſpectacle to the Romans. The ſoldiers embarked in boats were ordered to attack him with ſpears and other miſſile weapons. One of the boats was filled with water, and ſunk in conſequence of the fiſh ſpouting with great violence.

a. A variety of the grampus is deſcribed by the late Mr John Hunter, in the Philoſophical Tranſactions for 1787. It is diſtinguiſhed particularly by having a very large belly, which diminiſhes ſuddenly towards the region of the anus. The dorſal fin reaches nearer the tail. It has the form of a rectangular triangle, and is longer, but leſs elevated than the firſt deſcribed. The lower part of the body is not perfectly white, but is marked with brown and black ſpots.

5. Delphinus Gladiator, the *Sea-Sword.*

88 Characters. The form of the body of this ſpecies is conical. The dorſal fin reſembles a ſabre. The teeth are ſmall and ſharp.

89 Deſcription. This ſpecies comes very near the grampus in the form of the head; but it is chiefly diſtinguiſhed by the dorſal fin, which is three or four feet high, and about 18 inches broad at the baſe. It becomes ſlender towards the ſummit, and is incurvated towards the tail. This fin ſeems to be an offenſive inſtrument; for with it they ſtrike and wound the whale. The length is from 23 to 25 feet.

This ſpecies is gregarious. They are found together in ſmall bodies, which attack the whale with great fury, and tear off large maſſes from his body. When he becomes warm and fatigued, he lolls out his tongue, which is inſtantly ſeized by the watchful enemy. They even enter the mouth and tear out the tongue entirely, which ſeems with them to be a delicate morſel. The delphinus gladiator poſſeſſes immenſe ſtrength. They have been known to ſeize upon a dead whale that was dragged by a number of boats, and carry it to the bottom.

They are found near Spitzbergen, in Davis ſtraits, and on the coaſts of New England, and even ſo far north as the 79° of latitude. They are very fat, and the oil which they yield is eſteemed very good.

6. Delphinius Leucas.

Beluga, Pennant's Quadrup.; *Wittfiſch*, Anderſon's Iceland.

90 Characters. The form of the body is conical. There is no dorſal fin. The teeth are ſhort and blunt.

91 Deſcription. This ſpecies has been arranged by ſome naturaliſts among the whales, but having teeth in both jaws makes it properly come under this genus. The body reſembles a lengthened cone, having the baſe at the pectoral fins, and the vertex at the tail. The head is ſhort, and ends in an obtuſe ſnout, on the top of which is a protuberance in which is the blow-hole, which terminates in an oblique direction towards the poſterior part of the body. The jaws are nearly equal. The lower jaw is furniſhed with nine ſmall obtuſe teeth on each ſide, which reſemble in ſtructure the grinding teeth of quadrupeds. The teeth in the fore part of the jaw are the ſmalleſt. In the upper jaw the number of teeth is the ſame, but they are more pointed and ſlightly curved..

The eyes are not larger than thoſe of the hog. The opening of the mouth is ſmall, and the tongue is ſtrongly attached to the lower jaw. Behind the eyes is the external opening of the ear, but it is ſcarcely viſible.

The pectoral fins are broad and of an oval figure. The dorſal fin is wanting, but in its place there is an angular protuberance. The tail fin is divided into two rounded lobes.

The penis of the male is bony, of a white colour, and encloſed in a ſheath. The mammæ of the female are placed on each ſide of the organs of generation.

The whole body is white, and marked in young fiſhes with brown and blue ſpots. The ſkin is an inch thick, and covers a layer of fat of three inches. It is ſaid that the fleſh of this ſpecies has a reddiſh colour like that of pork.

It lives on different fiſhes, particularly the cod and the ſoal fiſh. And as the throat is of ſmall capacity, it is ſometimes ſuffocated in attempting to ſwallow fiſh of too large ſize. The female has one young at a time, which at birth is of a greeniſh colour, but becomes afterwards bluiſh, and as it advances in age is white. The females are gregarious, and the young follow at their ſides, imitating all their motions. This ſpecies is often obſerved following ſhips, and exhibiting by a thouſand different motions an amuſing ſpectacle.

It quits the open ſea during the rigour of winter, and enters the bays that are free from ice. It is ſeldom an object of trade, on account of the little advantage from the fat. Their arrival, however, is conſidered by the whale fiſhers as the fortunate preſage of an abundant fiſhery. The length is from 12 to 18 feet.

7. Delphinus Bidentatus.

92 Characters. The body is conical. The dorſal fin is ſpear-ſhaped. The ſnout is ſlender and flat. There are two ſharp teeth in the lower jaw.

93 Deſcription. This ſpecies in ſome of its characters reſembles the *delphinus turſio*, but in others is ſo different that it may properly be regarded as a diſtinct ſpecies. The forehead is convex and rounded. The upper jaw is flat, and ends in a beak like that of a duck; but there are only two ſharp teeth at the anterior extremity of the lower jaw. The pectoral fins, which are of an oval form and ſmall for the ſize of the body, are placed oppoſite to the angles of the mouth. The place of the dorſal fin correſponds to the origin of the tail, is ſpear-ſhaped, pointed, and inclines backward. The tail fin is divided into lobes forming by their union a creſcent. The lower part of the body is of a light brown colour, the upper part is browniſh black. This ſpecies is ſuppoſed to be from 30 to 40 feet long.

8. Delphinus Butskopf, *Bottle-headed*, or *Beaked Whale*.

94 Characters. The form of the body is conical. The dorſal fin is incurvated towards the tail. The ſnout is flat and ſlender. The upper jaw and the palate are furniſhed with ſmall teeth.

95 Deſcription. The body repreſents a cone whoſe ſummit is towards the tail. The head is of greater height than breadth. The front, which is full and round, becomes ſuddenly narrow, and ends in a flat beak rounded at the extremity. The breathing-hole is on the top of the head, oppoſite to the orbit of the eyes; it forms a creſcent whoſe horns are turned towards the tail. This is the

characteriſtic mark between this and the other ſpecies of *delphinus*. In place of teeth the ſurface of the palate and upper jaw are covered with ſmall points, which are unequal and hard. The tongue adheres to the lower jaw, and is notched at the edges. The edge of the upper jaw is alſo notched.

The eyes are convex as in quadrupeds. They are ſurrounded with eyelids, and are placed nearly in the middle of the ſide of the head.

The pectoral fins are attached to the lower part of the breaſt; they are ſmall in proportion to the ſize of the fiſh. The dorſal fin is nearer the tail than the ſnout: the ſummit is incurvated backward. The tail-fin is divided into two lobes in form of a ſickle.

The whole body excepting the belly is of a leaden colour.

In the *Journal de Phyſique* for the year 1789, M. Bauſſard has publiſhed an account of two cetaceous fiſhes which were taken near Honfleur in September of the preceding year. The largeſt was 23½ feet long, and the ſmalleſt 12½. The fiſhers of Honfleur perceived them at a diſtance ſtruggling on the ſtrand. When they approached they found the ſmalleſt ſtuck on the ſand in ſhallow water. The mother made many attempts to move her young one into deep water, and not only failed but ſtuck faſt by the head, the heavieſt part of the body. The fiſhermen firſt took poſſeſſion of the young one, ſecured it with ropes; and by their own exertions, aided by a horſe and the flowing of the ſea, ſucceeded in bringing it on ſhore. They then went into the water up to the middle to ſecure the mother; and having made above 50 wounds with knives on the head and back, and a large wound in the belly, at which the fiſh ſeemed to be in great pain, by uttering groans like thoſe of a hog, they were driven off by the violent motion of the tail. A ſmall anchor was then brought, which was introduced into the breathing-hole, and a rope was faſtened round the tail. The fiſh finding herſelf thus entangled, made ſuch violent efforts, that ſhe broke a thick rope, diſengaged herſelf from the anchor, and taking the advantage of the riſing tide, eſcaped and launched into the deep, at the ſame inſtant throwing up an immenſe quantity of water mixed with blood to the height of 12 feet. She was found next day floating on the water quite dead, at the diſtance of three leagues from Honfleur.

The following are the principal dimenſions of the young fiſh and the mother.

	Young one.		*Mother.*	
	Feet.	Inches.	Feet.	Inches.
Total length	12	6	23	6
Greateſt circumference	8	0	15	7
Diſtance from the breathing-hole to the extremity of the ſnout	1	11	4	4
Length of the dorſal fin	1	0	2	0
Height of ditto	0	7	1	3
Length of the pectoral fins	1	0	2	0
Breadth of ditto	0	7	1	3
Breadth of the tail-fin	3	2	6	10

M. Bonnaterre, Encyclopéd. Method.

9. Delphinus Feres.

96 Characters. In this ſpecies there is one fin on the back. The head is rounded. The teeth are oval and obtuſe. The head is nearly of the ſame height as the length. It is very thick at the top, and ſuddenly diminiſhing towards the anterior part ends in a ſhort round ſnout.

97 Deſcription. The jaws are equal; they are covered with membranous lips, and furniſhed internally with a row of teeth; 20 have been reckoned in each jaw. The form of the teeth conſtitutes the diſtinctive character of the ſpecies. The large and the ſmall teeth are equal in number. The largeſt are above an inch long by half an inch broad. The ſmall teeth are only five or ſix lines in length.

The ſkeleton of one of this ſpecies is preſerved in the cabinet of natural hiſtory at Frejus in France. The length is 14 feet. The bones of the ſkull are 1 foot 10 inches long, and 1 foot 5 inches broad.

This ſpecies is found in the Mediterranean ſea.

Chap. II. *Of the Anatomy and Phyſiology of Cetaceous Fiſhes.*

98 Difficulties in acquiring a knowledge of their ſtructure. It has fallen to the lot of few anatomiſts to have an opportunity of examining with accuracy the ſtructure of cetaceous fiſhes. The ſame difficulties which have retarded the progreſs of their natural hiſtory, operate perhaps ſtill more powerfully in preventing the acquiſition of information with regard to their anatomical ſtructure. They are not inhabitants of thoſe parts of the world where this knowledge is in that improved ſtate to render ſuch inveſtigations ſucceſsful; and when they are accidentally found on the ſhores of civilized countries, the anatomiſt, whoſe ſkill and dexterity only could be advantageouſly employed in the examination, is not always at hand, and they are too large to be tranſported to the diſſecting-room, where the nature and ſtructure of the different parts could be patiently traced and faithfully demonſtrated. Several of the ſpecies of this tribe of fiſhes have been diſſected by the late Mr John Hunter, the detail of which he has given in a paper on the Structure and Economy of Whales, in the Philoſophical Tranſactions for the year 1787; and to this paper we muſt acknowledge ourſelves indebted for the principal part of the anatomical knowledge which we propoſe to lay before our readers in the preſent chapter.

99 Diſtinctive characters. We have already mentioned the characters which diſtinguiſh the whale tribe from fiſhes in general. They have indeed nothing peculiar to fiſh except that they live in the ſame element, and have the ſame powers of progreſſive motion as thoſe fiſh, which from their nature muſt move with great velocity. This ſeems to be the caſe with all fiſh which come to the ſurface of the water, as the whales muſt do for the purpoſe of reſpiration. It has alſo been obſerved that they are more cloſely allied to quadrupeds than to fiſh. 100 Allied to quadrupeds. They have in many reſpects the peculiar ſtructure and economy of parts which belong to this claſs of animals. They are furniſhed with lungs, breathe the air, and have warm blood.

101 Fitted for rapid motion. This tribe of animals is peculiarly fitted by their external form for dividing the water in progreſſive motion, and for moving with conſiderable velocity. And, on account of the uniformity of the element in which they live, the form of their bodies is more uniform than in animals of the ſame claſs that live on land.

The

102 Form of the head; The form of the head is commonly a cone or inclined plane. The ſpermaceti whale is an exception to this, in which it terminates in a blunt ſurface. The head is larger in proportion to the body than in quadrupeds, and ſwells out laterally at the articulation of the lower jaw. This ſeems to be of advantage to the animal in catching its prey, as there is no motion of the head on the body.

103 of the body. Behind the pectoral fins, at the inſertion of which the circumference is greateſt, the body gradually diminiſhes to the ſpreading of the tail. The body is flattened laterally; and it would appear that the back is ſharper than the belly, which is nearly flat.

104 Power of the tail. The progreſſive motion of the animal is performed by the tail, which moves the broad termination or lobes; operating in the ſame manner as an oar in ſculling a boat. And for the purpoſe of preventing any obſtruction in moving through the water, it may be obſerved that all the external parts of the claſs mammalia, that live on land, are either entirely wanting, or are concealed under the ſkin in cetaceous fiſhes.

Sect. I. *Of the Bones.*

105 The ſkeleton gives no idea of the general form. The bones alone, Mr Hunter obſerves, when properly united into the ſkeleton, in many animals give the general ſhape and character. But this is not ſo decidedly the caſe in this order of animals. In them the head is immenſely large, the neck ſmall, there are few ribs, in many a very ſhort ſternum, and no pelvis, with a long ſpine terminating in a point, ſo that theſe bones being merely joined together do not afford any idea of the regular ſhape of the animal. The different parts of the ſkeleton are ſo encloſed, and the projecting ſpaces between the parts ſo filled up, that they are altogether concealed, and give to the animal externally an uniform and elegant form.

106 Bones of the head; The great ſize of the bones of the head leaves but a ſmall cavity for the brain. In the ſpermaceti whale it is not eaſy to diſcover where the cavity of the ſkull lies. This is alſo the caſe with the large whalebone and bottle-noſe whale. In the porpoiſe, the ſkull conſtitutes the principal part of the head. For the brain is found to be conſiderably larger in proportion to the ſize of the animal. The bones of one genus differ very much from thoſe of another. In the ſpermaceti and bottle-noſe whales, the grampus and the porpoiſe, the lower jaws, eſpecially at the poſterior ends, reſemble each other; but in others it is very different. The number of particular bones is alſo obſerved to vary very much.

107 of the neck and back; *Vertebræ.*—The piked whale has ſeven vertebræ in the neck, 12 in the back, and 27 to the tail. This makes the whole number 46. In the porpoiſe the cervical verebræ are ſeven in number. There is one common to the neck and back, 14 proper to the back, and 30 to the tail, making in whole 51. The cervical vertebræ of a bottle-noſe whale, were the ſame in number as thoſe of the porpoiſe. There were 17 in the back and 37 in the tail, which makes the whole number 60. Four of the vertebræ of the neck in the porpoiſe are anchyloſed, or have grown together. The atlas in every one of this order of animals that has been examined is the thickeſt of the vertebræ. It ſeems to be compoſed of two. There is no articulation between the firſt and ſecond vertebræ of the neck to admit of rotatory motion. The vertebræ of the neck are very thin, ſo that the diſtance between the head and ſhoulders is as ſhort as poſſible.

108 of the breaſt. *Sternum*, or *Breaſtbone.*—This is very flat in the piked whale, and conſiſts of a ſingle very ſhort bone. The breaſtbone of the porpoiſe is conſiderably longer: it is compoſed of three bones, which are of ſome length in the ſmall bottle-noſe whale. The firſt rib of the piked whale, and the three firſt of the porpoiſe are articulated to the ſternum.

109 Ribs *Ribs.*—The ſmall bottle-noſe whale, diſſected by Mr Hunter, had 18 ribs on each ſide; and the porpoiſe had 16. Fifteen ribs have been reckoned in the ſkeleton of the dolphin. A large whalebone whale had 15 ribs on each ſide, which were 21 feet long and 18 inches in circumference. The ſpermaceti whales which were thrown a-ſhore on the coaſt of Brittany in France, had only 8 ribs on each ſide. They were 5 feet long and 6 inches in circumference.

110 articulated with two vertebræ. The ends of the ribs that have two articulations, in the whole of this tribe, Mr Hunter obſerves, are articulated with the body of the vertebræ above, and with the tranſverſe proceſſes below, by the angles, ſo that there is one vertebræ common to the neck and back. In the large whalebone whale the firſt rib is bifurcated, and conſequently is articulated with two vertebræ.

111 Pectoral fins ſimilar to the extremities of quadrupeds. *Pectoral* or *lateral fins.*—Theſe are analogous, and ſomewhat ſimilar in conſtruction to the anterior extremities of quadrupeds. They are compoſed of a ſcapula or ſhoulder-blade, os humeri, ulna, radius, carpus, and metacarpus, which laſt may include the fingers, the number of bones being ſuch as may be reckoned fingers, although they are included in one general covering. The number of bones in each is different, the fore-finger has five, the middle and ring-finger has ſeven, and the little finger has four. Theſe bones are not articulated by capſular ligaments as in quadrupeds, but by intermediate cartilages attached to each bone. Theſe cartilages are nearly equal in length to one-half of the bone. This conſtruction gives firmneſs and a conſiderable degree of pliability to the whole.

112 Teeth *Teeth.*—Of this tribe of animals ſome have teeth in both jaws, ſome have them only in one, while there are others which have none at all. The teeth cannot be divided into claſſes as in quadrupeds. They are all pointed teeth, and are pretty much ſimilar in form and ſize. Each tooth is a double cone, one part of which is faſtened in the jaw, and the other projects above the gum. In ſome, indeed, the fang is flattened and thin at the extremity; and in others it is curved.

113 formed differently from quadrupeds. The formation of the teeth, and their progreſs afterwards, ſeems to be different from that of quadrupeds. For they ſeem to form in the gum, ſo that they muſt either extend and ſink into the jaw, or the alveoli muſt riſe to encloſe them. Mr Hunter thinks this laſt the moſt probable, ſince the depth of the jaw is increaſed, ſo that the teeth ſeem to ſink deeper and deeper in it. This mode of formation is obſerved in jaws that are not fully grown; for, as happens in other animals, the teeth increaſe in number as the jaw lengthens.

114 Are not ſhed. It does not appear that they ſhed their teeth, or

have new ones formed ſimilar to the old. This indeed ſeems ſcarcely poſſible from the ſituation in which they are originally formed.

115 Peculiar ſubſtance. *Whalebone.*—This is a ſubſtance peculiar to the whale. It is of the ſame nature as horn. It is therefore entirely compoſed of animal matter, and is extremely elaſtic. The name of bone is undoubtedly improper, as it has no earthy matter in its compoſition; but as it has been commonly employed we ſhall ſtill retain it.

116 Two kinds. There are two kinds of whalebone. One kind is got from the large whale; the other from a ſmaller ſpecies. It is placed in the inſide of the mouth, and is attached to the upper jaw. It conſiſts of thin plates of different ſizes in different parts of the mouth. The length and the breadth of the whalebone, although not always, in general correſpond pretty nearly; thoſe plates that are longeſt being alſo the broadeſt.

117 Arrangement. Theſe plates are arranged in ſeveral rows on the outer edge of the upper jaw, ſimilar to the teeth in other animals, and ſtand parallel to each other, one edge being towards the circumference of the mouth, and the other towards the inſide. They are placed at unequal diſtances in different parts of the mouth. In the piked whale, they are only one-fourth of an inch aſunder at the greateſt diſtance. In the great whale the diſtances are greater.

118 Outer row. The longeſt plates are in the outer row; and the length is proportioned to the different diſtances between the different parts of the jaws. Some of them are 14 or 15 feet long, and 12 or 15 inches broad. Towards the anterior and poſterior part of the mouth they are very ſhort. They riſe for half a foot or more of the ſame breadth, and afterwards ſhelve off from the inſide till they come nearly to a point at the outer. The exterior of the inner rows are the longeſt, correſponding to the termination of the declivity of the outer, and become ſhorter and ſhorter, till they hardly riſe above the gum.

119 Inner row. The inner rows are cloſer than the outer, riſe almoſt perpendicularly from the gum, are longitudinally ſtraight, and have leſs declivity than the other. The plates of the outer row make a ſerpentine line laterally, and in the piked whale the outer edge is the thickeſt. Round the line made by their outer edges runs a ſmall white bead, which is formed along with the whalebone, and wears down with it; both edges of the ſmaller plates are nearly the ſame thickneſs. 120 Hair. In all of the plates, the termination is in a kind of hair, as if the plate were divided into innumerable ſmall parts. The exterior plates have the ſtrongeſt and alſo longeſt.

The whole ſurface of the mouth reſembles the ſkin of an animal covered with ſtrong hair; and under this ſurface the tongue lies when the mouth is ſhut. In the piked whale the projecting whalebone remains entirely on the inſide of the lower jaw, when the mouth is ſhut, becauſe the jaws meet everywhere along their ſurface. Mr Hunter is at a loſs to explain how this is effected in large whales, in which the lower jaw is ſtraight, forming a horizontal plane; but the upper jaw being an arch, cannot be hid by the former. He therefore ſuppoſes that a broad upper lip reaches to the lower jaw and covers the whole.

121 Formation peculiar. The formation of the whalebone is in one reſpect ſimilar to that of horn, hair, &c. but it has another mode of growth and decay which is peculiar. The plates form upon a thin vaſcular ſubſtance, which does not immediately adhere to the jaw-bone; but which has a more denſe vaſcular ſubſtance between. From this ſubſtance thin broad proceſſes, correſponding to each plate, are ſent out; and on theſe proceſſes the plate is formed, in the ſame way as the horn on the bony cone, or the tooth on the pulp. Each plate is neceſſarily hollow at the growing end, and the firſt part of the growth takes place on the inſide of the hollow. But beſides this mode of growth, it receives additional layers on the outſide, which are formed on the vaſcular ſubſtance extended along the ſurface of the jaw. This part alſo forms upon it a kind of horny ſubſtance between each plate, which is very white, riſes with the whalebone, and becomes even with the outer edge of the jaw, and the termination of its outer part forms the bead above mentioned. This intermediate ſubſtance fills up the ſpace between the plates, as high as the jaw, and is ſimilar to the alveolar proceſſes, keeping them firm in their places.

As both the whalebone and the intermediate ſubſtance are conſtantly growing, a determined length muſt be ſuppoſed neceſſary, ſo that there muſt be a regular mode of decay eſtabliſhed, which does not depend entirely on chance or accidental circumſtances. In its growth there ſeems to be a formation of three parts; one from the riſing cone, which is the center, a ſecond on the outſide, and a third being the intermediate ſubſtance. Theſe appear to have three ſtages of duration; for that which forms on the cone, it is ſuppoſed makes the hair; and that on the outſide makes principally the plate of the whalebone; and this, when got a certain length, breaks off, leaving the hair projecting, becoming at the termination very brittle; and the third or intermediate ſubſtance, by the time it riſes as high as the edge of the ſkin of the jaw, decays and ſoftens away.

Plate CXLI. fig. 3, 4, 5. The uſe which has been aſcribed to the whalebone, is principally for the retention of the food till it is ſwallowed; for it is ſuppoſed that the fiſh which are taken by the ſpecies of whale having this peculiar conſtruction of the mouth, are ſmall when compared with its ſize.

Sect. II. *Of the Skin and Muſcles.*

122 Cuticle. The cuticle, or ſcarf-ſkin, in this order of animals, is ſimilar to that on the ſole of the foot in the human ſpecies. It ſeems to be compoſed of a number of layers, which may be ſeparated by ſlight putrefaction. Mr Hunter ſuſpects that this ariſes from a ſucceſſion of cuticles being formed. The fibres of the cuticle appear to have no particular direction. It has no elaſticity, but is eaſily torn aſunder. The internal layer is tough and thick, and in the ſpermaceti whale, the external ſurface reſembles coarſe velvet. The cuticle gives the colour to the animal. In parts that are dark, a dirty coloured ſubſtance has been waſhed away in ſeparating the cuticle from the true ſkin. This ſeems to be the *rete mucoſum*.

123 True ſkin. The cutis or true ſkin in cetaceous fiſhes is extremely villous in the external ſurface, correſponding to the rough ſurface of the cuticle, and forming ridges in

ſome parts. The villi, which are ſoft and pliable, float in water, and are obſerved to be longer or ſhorter in proportion to the ſize of the animal. In ſome they are one-fourth of an inch in length, and in all they are very vaſcular.

The cutis ſeems to be the termination of the cellular membrane of the body more cloſely united, having ſmaller interſtices, and becoming more compact. In fat animals the diſtinction between ſkin and cellular membrane is ſmall, the gradation from the one to the other being almoſt imperceptible; for the cells of both membrane and ſkin being loaded with fat, the whole ſeems to be one uniform ſubſtance. A looſe elaſtic ſkin would appear to be improper in this tribe of animals; it is therefore always on the ſtretch by the adipoſe membrane being loaded with fat. In ſome places, indeed, where it ſeems to be neceſſary, it poſſeſſes conſiderable elaſticity, as at the ſetting on of the fins, and under the jaw, round the opening of the prepuce, the nipples, &c. to allow free motion in theſe parts, where it is obſerved that there is more reticular and leſs adipoſe membrane.

In the piked whale there is a very ſingular inſtance of an elaſtic cuticular contraction. The whole ſkin of the fore part of the neck and breaſt, and as far down as the middle of the belly, is extremely elaſtic; but it receives an increaſed lateral elaſticity by being ribbed longitudinally. It is not eaſy to ſay why this part which covers the thorax ſhould poſſeſs ſo much elaſticity, for this part of the body cannot be increaſed in ſize.

124 Muſcles. The fleſhy or muſcular parts of cetaceous fiſhes reſemble that of moſt quadrupeds. Perhaps it comes nearer to that of the bull or horſe than to that of any other animal. Some of the fleſhy parts are very firm; and about the breaſt and belly they are mixed with tendons.

125 Tendons. The body and tail of this tribe of animals are compoſed of a ſeris of bones connected together, and moved as in fiſh; but the movements are produced by long muſcles, with long tendons. This renders the body thicker, and the tail at its ſtem ſmaller, than any other ſwimming animal.

The depreſſor muſcles of the tail, which are ſimilar in ſituation to the pſoæ, make two very large ridges on the lower part of the cavity of the belly, riſing much higher than the ſpine, and the lower part of the aorta paſſes between them. Theſe two large muſcles go to the tail, which may be conſidered as the two poſterior extremities united in one.

The muſcles of cetaceous animals loſe their fibrous ſtructure a very ſhort time after death, and become as uniform a texture as a maſs of clay, and even ſofter. This change no doubt ariſes from incipient putrefaction, although no evidence of this proceſs being begun is to be had from any offenſive ſmell. This change is moſt remarkable in the large muſcles, as thoſe of the back and the pſoæ muſcles.

The Tail.—The conſtruction of the tail affords an inſtance of a ſingular piece of mechaniſm. It is compoſed of three layers of tendinous fibres, which are covered with the cutis and cuticle. Two of theſe layers are external; the other is internal. The direction of the fibres of the external layers is the ſame as in the tail, forming a ſtratum about one-third of an inch thick; but varying, as the tail is thicker or thinner. The middle layer is compoſed entirely of tendinous fibres, paſſing directly acroſs between the two external layers, their length being in proportion to the thickneſs of the tail. 126 very ſtrong. This ſtructure gives amazing ſtrength to this part of the animal.

The ſubſtance of the tail is ſo firm and compact, that the veſſels remain in their dilated ſtate, even when they are cut acroſs. This ſection conſiſts of a large veſſel, ſurrounded by as many ſmall ones, as can come in contact with its external ſurface. The fins are merely covered with a ſtrong condenſed adipoſe membrane.

Sect. III. *Of the Organs of Digeſtion and Excretion.*

127 Gullet. In the whale, the œſophagus begins at the fauces, as in other animals. At the beginning it is circular, but is ſoon divided into two paſſages by the epiglottis croſſing it. Paſſing down in the poſterior mediaſtinum, to which it is attached by a broad part of the ſame membrane, its anterior ſurface makes the poſterior part of a cavity behind the pericardium. Having paſſed through the diaphragm, it enters the ſtomach, and is lined with a very thick, white, and ſoft cuticle, which is continued into the firſt cavity of the ſtomach. The inner or true coat of the œſophagus is white, and of conſiderable denſity, but it is not muſcular; for it is thrown into large longitudinal folds, by the contraction of the muſcular fibres. This coat is very glandular; many orifices of glands, eſpecially near the fauces, are viſible. The œſophagus is larger than it is in quadrupeds, in proportion to the bulk of the animal, but of leſs ſize than it uſually is in fiſh. One in the piked whale that was meaſured, was three inches and a half wide.

128 Stomach and inteſtines. The ſtomach, as in other animals, lies on the left ſide of the body, and terminates on the pylorus towards the right. The duodenum paſſes down on the right ſide, as in the human body, lies on the right kidney, and then paſſes to the left ſide, behind the aſcending part of the colon and root of the meſentery, comes out on the left ſide, and getting on the edge of the meſentery, becomes a looſe inteſtine, forming the jejunum. In this courſe behind the meſentery, it is expoſed as in moſt quadrupeds. The jejunum and ileum paſs along the edge of the meſentery downwards, to the lower part of the abdomen. The ileum, near the lower end, makes a turn towards the right ſide, mounts upwards round the edge of the meſentery, paſſes a little way on the right, as high as the kidney, and there enters the colon or cæcum. The cæcum, which is about ſeven inches long, and reſembles that of the lion or ſeal, lies on the lower end of the kidney, conſiderably higher than in the human body; and this renders the aſcending part of the colon ſhort. The colon paſſes obliquely up the right ſide, a little towards the middle of the abdomen; and when as high as the ſtomach, croſſes to the left, and acquires a broad meſocolon. It lies here on the left kidney, and in its paſſage down inclines more and more to the middle line of the body. When it has reached the lower part of the abdomen, it paſſes behind the uterus, and along the vagina in the female; between the two teſticles, and behind the bladder and root of the penis, in the male; bending down, to open on what is called the belly of the animal. In its whole

courſe it is gently convoluted. In thoſe which have no cæcum, and, therefore, can hardly be ſaid to have a colon, the inteſtine, before its termination in the rectum, makes the ſame kind of ſweep round the other inteſtines, as the colon does where there is a cæcum.

For the ſize of the animal, the inteſtines are not large. In thoſe of 18 or 24 feet long, they are not larger than in the horſe; the colon is very ſhort, and has little more capacity than the jejunum and ileum. This is a circumſtance common to carnivorous animals. In the piked whale, the length from the ſtomach to the cæcum is 28½ yards, the length of the cæcum ſeven inches, and of the colon to the anus, two yards and three quarters.

The teeth, in the ruminating tribe of animals, point out the kind of ſtomach, cæcum, and colon; but in others, as the horſe, lion, &c. the appearances of the teeth only indicate the kind of colon and cæcum. In the cetaceous tribe of fiſhes, whether they have teeth or not, the ſtomachs vary little, and the circumſtance of cæcum ſeems not to depend on either teeth or ſtomach.

The ſtomach, in all the ſubjects examined by Mr Hunter, conſiſted of ſeveral bags continued from the firſt on the left, towards the right, where the laſt terminates in duodenum.

129 Number of ſtomachs.

The number and ſize of the ſtomachs differ conſiderably. In the porpoiſe, grampus, and piked whale, there are five; in the bottle-noſe whale, ſeven. The two firſt ſtomachs in the porpoiſe, bottle-noſe, and piked whale, are the largeſt; the others are ſmaller, but not uniformly ſo.

130 Firſt.

The firſt ſtomach has very much the ſhape of an egg with the ſmall end downwards, and is lined with a continuation of the cuticle from the œſophagus. In ſome, the œſophagus enters the upper end of the ſtomach; in others, it enters poſteriorly and obliquely.

131 Second.

The ſecond ſtomach in the piked whale is very large, and rather longer than the firſt, is of the ſhape of the Italic letter *S*, and paſſes out from the upper end of the firſt on its right ſide, by nearly as large a beginning as the body of the bag. In the porpoiſe, where this ſecond ſtomach begins, the cuticle of the firſt ends The inſide of the ſecond ſtomach has unequal rugæ like an irregular honey-comb. In the piked whale the rugæ are longitudinal, and in many places deep, ſome of them being united by croſs bands: in the porpoiſe the folds are thick, maſſy, and indented into each other. This ſtomach opens into the third by a round contracted orifice.

132 Third.

The third ſtomach is the ſmalleſt, appears only to be a paſſage between the ſecond and fourth, has no peculiar internal ſtructure, and terminates in as large an opening as at its beginning. It is from one to five inches long.

133 Fourth.

The fourth ſtomach is leſs than either the firſt or ſecond. It ſeems to be flattened between the ſecond and fifth; and in ſome, as the porpoiſe, it is long, and paſſes in a ſerpentine courſe like an inteſtine. The internal ſurface is regular and villous, and opens on its right ſide into the fifth.

134 Fifth.

The fifth ſtomach is round in the piked whale; in the porpoiſe it is oval: it is ſmall, and terminates in the pylorus without any appearance of a valvular ſtructure Its coats are thinner than thoſe of the fourth; the internal ſurface is even, and it is commonly tinged with bile. In ſome, as the piked whale and the large whalebone whale, there is a cæcum; in others, as the porpoiſe, grampus, and bottle-noſe whale, it is wanting.

The ſtructure of the inner ſurface of the inteſtine is very ſingular. The inner ſurface of the duodenum of the piked whale has longitudinal rugæ or valves, at ſome diſtance from each other, and receiving lateral folds. The inner coat of the ileum and jejunum appears in irregular folds, which may vary according to the action of the muſcular coat of the inteſtine, yet do not ſeem to depend entirely on this contraction. In ſome the whole tract of the inteſtine is thrown into large cells which are ſubdivided into ſmaller. Theſe cells have the appearance of pouches with the mouths downwards, and act like valves when any thing is attempted to be paſſed in a contrary direction.

135 Reſembles the human.

Liver.—In this tribe of animals there is a conſiderable degree of uniformity in the liver, which in ſhape bears a near reſemblance to the human liver, but is probably leſs firm in its texture. The right lobe is the largeſt and thickeſt, and there is a large fiſſure between the two lobes, in which the round ligament paſſes. Toward the left the liver is much attached to the ſtomach. The gall-bladder is wanting; but the hepatic duct, which enters the duodenum about ſeven inches beyond the pylorus, is large.

136 Situation.

Pancreas.—The pancreas is a long flat body, having its left end attached to the right ſide of the firſt cavity of the ſtomach. It croſſes the ſpine at the root of the meſentery, joins the hollow curve of the duodenum near to the pylorus, adheres to that inteſtine, and its duct enters that of the liver near the termination in the gut.

137 Small.

Spleen.—The ſpleen, which is involved in the epiploon, is ſmall for the ſize of the animal. In ſome of the tribe, as in the porpoiſe, there are one or two ſmall ones, not larger in ſize than a nutmeg, and ſometimes ſmaller. They are placed in the epiploon behind the others.

138 Conglomerated.

Kidneys—The kidneys in this whole tribe of animals are conglomerated. They are made up of ſmaller parts, which are connected only by cellular membrane, blood-veſſels, and ducts. The ſmaller portions are of a conical figure; the apex is placed towards the centre of the kidney, and the baſe forms the external ſurface. Each portion is compoſed of a cortical and tubular ſubſtance, the tubular terminating in the apex, which apex makes the mamilla. Each mamilla has an infundibulum, which is long, and at its beginning wide, embracing the baſe of the mamilla, and becoming ſmaller. Theſe infundibula at laſt unite and form the ureter.

Ureters and *Bladder.*—The ureter comes out of the kidney at the lower end, and paſſes along to the bladder, which it enters very near to the urethra.

139 Small.

The bladder, which is of an oblong ſhape, is ſmall for the ſize of the animal. In the female the urethra paſſes along to the external ſulcus or vulva, and opens juſt under the clitoris, as in the human ſubject. The *capſulæ renales*, when compared to the human, are ſmall for the ſize of the animal. They are flat and of an oval figure. They are compoſed of two ſubſtances; of an external ſubſtance, which has the direction of its fibres towards the center; and of an internal ſubſtance, which is more uniform and has leſs of the fibrous appearance.

Sect. IV. *Of the Organs of Circulation and Reſpiration.*

140 Heart large. 1. Circulation.—The heart and blood-veſſels, eſpecially the veins, are probaby larger in proportion to their ſize than in the quadruped. The heart is encloſed in its pericardium, and is attached to the diaphragm as in the human body. It is compoſed of two auricles and two ventricles, is flatter than in the quadruped, and adapted to the ſhape of the cheſt. The auricles have a greater number of faſciculæ, paſſing more acroſs the cavity from ſide to ſide, than in many other animals; and beſides have conſiderable muſcularity and elaſticity. 141 Structure not peculiar. There is nothing peculiar in the ſtructure of the ventricles of the heart, in their valves, in the arteries, or in their diſtribution, all which have a ſimilarity to other animals where parts are nearly ſimilar.

142 Blood in great proportion. Animals of this tribe have a greater proportion of blood than any other yet known; and ſome arteries are apparently intended as reſervoirs, where a great quantity of blood is required in any part. There is a net-work of arteries, formed of the intercoſtal arteries, and running between the pleura, ribs, and their muſcles. The ſpinal marrow is ſurrounded with a net-work of arteries in the ſame manner, eſpecially where it paſſes out from the brain, where a thick ſubſtance is formed by their ramifications and convolutions.

In examining particular parts which bear any relation to the ſize of the animal, if we have been accuſtomed to ſee them in the middle-ſized animals, we muſt behold them with aſtoniſhment in animals like the whale, which ſo far exceed the common bulk. The heart and aorta of the ſpermaceti whale, for inſtance, appear of immenſe ſize, when we make this kind of compariſon. The latter meaſures a foot in diameter; and the former was too large to be contained in a wide tub. 143 Circulation aſtoniſhing. Conſidering the quantity of circulating fluid in ſo large a veſſel, that probably 10 or 15 gallons of blood are thrown out at a ſingle ſtroke, and the great velocity with which it moves, the mind muſt be filled with wonder.

144 Veins. The veins ſeem to have nothing peculiar in their ſtructure, if we except the veins in the folds on the ſkin of the breaſt, as in the piked whale, where, and in ſimilar places, it was neceſſary to have the elaſticity increaſed.

145 Red globules in great proportion. The blood of this order of animals is ſimilar to that of quadrupeds Mr Hunter ſeems to think that the quantity of red globules is in larger proportion; and he ſuppoſes that this increaſed quantity of red particles may have ſome effect in aiding to keep up the animal heat; for as they live in a very cold climate or atmoſphere compared with the heat of their bodies, it is readily carried off, and therefore ſome help of this kind becomes neceſſary.

The quantity of blood in this tribe of animals is comparatively greater than in the quadruped, and therefore it is probable that it amounts to more than in any known animal. In them too the red blood is carried to the extreme parts of the body, ſimilar to what happens in the quadruped, but different from fiſh.

2. Respiration.—Some parts of the organs of reſpiration in animals that live on land ſeem to be fitted for a compound action, as for inſtance the larynx, which is adapted both for reſpiration, deglutition, and ſound; but in the whale tribe it ſeems to be adapted only for reſpiration.

146 Varieties. *Larynx.*—The larynx varies much in ſtructure and ſize in the different ſpecies. It is compoſed of the os hyoides, thyroid, cricoid and two arytenoid cartilages. The os hyoides was larger, while the cartilages were much ſmaller, in the bottle-noſe whale of 24 feet long than in the piked whale of 17 feet. In the bottle-noſe the os hyoides is compoſed of three bones, with two whoſe ends are attached to it, making five in all. In the porpoiſe it conſiſts of only one bone ſlighty bent: it has no attachment to the head as in many quadrupeds.

The thyroid cartilage, in the piked whale, is broad from ſide to ſide, and has two lateral proceſſes which are long, and paſs down the outſide of the cricoid, near to its lower end, and are joined to it, as in the human ſubject. The cricoid cartilage is broad and flat, making the poſterior and lateral part of the larynx, and is much deeper behind and laterally than before. The two arytenoid cartilages project much, and are united to each other till near their ends; they are articulated on the upper edge of the cricoid, croſs the cavity of the larynx obliquely, and make the paſſage at the upper part a groove between them. In ſeveral of the tribe, the epiglottis makes a third part of the paſſage, and completes the glottis by forming it into a canal. No thyroid gland has been diſcovered.

147 Not divided into lobes. *Lungs.*—The lungs are two oblong bodies, one on each ſide of the cheſt, but are not divided into ſmaller lobes as in the human ſubject. They are of conſiderable length, but not ſo deep as in the quadruped, from the heart being broad and flat, and filling up the cheſt. They are increaſed in ſize by riſing higher up in the cheſt, and paſſing farther down on the back. 148 Very elaſtic. The lungs are extremely elaſtic in their ſubſtance, and have the appearance and conſiſtence of the ſpleen of an ox. The branches of the bronchiæ which ramify into the lungs, have the cartilages rounded, which ſeems to admit of greater motion between them.

The pulmonary cells are ſmaller than in the quadruped, and communicate with each other, which thoſe of the quadruped do not; for by blowing into one branch of the trachea, the whole lungs may be filled.

149 Diaphragm. The diaphragm has not the ſame attachments as in the quadruped; becauſe the ribs in this tribe do not complete the cavity of the thorax. The diaphragm is therefore unconnected forwards to the abdominal muſcles, which are very ſtrong, being a mixture of muſcular and tendinous fibres. The cheſt is longeſt in the direction of the animal at the back, by the diaphragm paſſing obliquely backwards, and reaching low on the ſpine. The parts immediately concerned in reſpiration are very ſtrong. This is particularly the caſe with the diaphragm. This ſeems neceſſary, as the animal muſt enlarge the cheſt in ſo denſe a medium as water, the preſſure of which muſt be greater than the counterpreſſure from the air inſpired. And for the ſame reaſon, expiration muſt be eaſily performed, for the preſſure of the water and the natural elaſticity of the parts are greater than the reſiſtance of the internal air, ſo

that it may be produced without any immediate action of muſcles. In theſe animals the diaphragm ſeems to be the principal agent in inſpiration.

150 Noſtrils chiefly intended for reſpiration.

Blow-hole, or *paſſage for the air.*—In animals breathing air, the noſe is the paſſage for the air, and the ſeat of the organ of ſmelling; but in ſome of the cetaceous tribe, this ſenſe ſeems to be wanting; in them, therefore, the noſtrils are intended merely for reſpiration. The membranous portion of the poſterior noſtrils is one canal; but in the bony part, in moſt of them, it is divided into two. In thoſe which have it divided, it is in ſome continued double through the anterior ſoft parts, and opens by two orifices; but, in others, it unites again in the membranous part, making externally only one orifice, as in the porpoiſe, grampus, and bottle noſe whale. At its beginning in the fauces, it is a roundiſh hole, ſurrounded by a ſtrong ſphincter muſcle, which graſps the epiglottis; the canal beyond this enlarges, and opens into the two paſſages in the bones of the head. In the ſpermaceti whale, in which the canal is ſingle, it is thrown a little to the left ſide. After theſe canals emerge from the bones near the external opening, they become irregular, and have ſulci paſſing out laterally, of irregular forms, with correſponding eminences; and the ſtructure of theſe eminences is muſcular and fatty.

Pl. CXLI. fig. 1, 2.

Where there is only one external opening, it is tranſverſe, as in the porpoiſe, grampus, bottle-noſe, and ſpermaceti whale; but when it is double, it is longitudinal, as in the large whalebone whale, and in the piked whale. Theſe openings form a paſſage for the air to and from the lungs; for it would be impoſſible for theſe animals to breathe through the mouth.

151 Opening well fitted for reſpiration.

In the whole tribe, the ſituation of the opening on the upper ſurface of the head is well adapted for the purpoſe of reſpiration; for it is the firſt part that comes to the ſurface of the water in the natural progreſſive motion of the animal. The animals of this order do not live in the medium which they breathe. This requires a particular conſtruction of the organs which conduct the air to the lungs, that the water in which they live may not interfere with the air they breathe. The projecting glottis paſſes into the poſterior noſtrils, by which means it croſſes the fauces, and divides them into two paſſages.

The beginning of the poſterior noſtrils, which anſwers to the *palatum molle* in the quadruped, has a ſphincter which graſps the glottis, by which its ſituation is rendered ſtill more ſecure, and the paſſages through the head, acroſs the fauces and along the trachea, are rendered one continued canal. This union of glottis and epiglottis with the poſterior noſtril making only a kind of joints, admits of motion, and of a dilatation and contraction of the fauces in deglutition, from the epiglottis moving more in or out of the poſterior noſtril. This tribe of animals having no projecting tongue, and therefore wanting its extenſive motion, and the power of ſucking things into the mouth, may perhaps require this peculiarity of conſtruction to render the communication between the air and lungs more perfect. But how far this is the caſe, in the preſent ſtate of our knowledge of the ſtructure and economy of theſe reſpiratory organs, it is not eaſy to ſay.

SECT. V. *Of the Brain and Organs of Senſe.*

152 Not in proportion to the bulk.

The brain.—In the different genera of the cetaceous tribe of animals, the brain differs much, and alſo in the proportion it bears to the bulk of the animal. The porpoiſe has the largeſt brain, and thus comes neareſt to the human ſubject. The whole brain is compact. The anterior part projects leſs forward than in the quadruped; the *medulla oblongata* is leſs prominent, and lies on the hollow made by the lobes of the cerebellum.

The brain is compoſed of diſtinctly marked cortical and medullary ſubſtances. The medullary ſubſtance is very white; the cortical like the tubular ſubſtance of the kidney; and theſe two ſubſtances, ſeem to be in the ſame proportion as in the human brain. The lateral ventricles are large. They paſs cloſe round the ends of the *thalami nervorum opticorum*. The thalami are large: the *corpora ſtriata* ſmall. Moſt of the other parts have a great reſemblance to ſimilar parts in the human brain.

153 Subſtance fibrous.

The ſubſtance of the brain is more viſibly fibrous than in any other animal. The fibres paſs from the ventricles as from a center to the circumference, and continue through the cortical ſubſtance. The brain of the piked whale weighed four pounds 10 ounces.

154 Spinal marrow.

The ſpinal marrow in this tribe of animals is proportionally ſmaller than in the human ſpecies. It is largeſt in the porpoiſe where the brain is largeſt, bearing ſome proportion to the quantity of brain. But this is not always the caſe; for in the ſpermaceti whale, where the brain is ſmall, the ſpinal marrow is proportionally largeſt. It terminates about the twenty-fifth vertebra, beyond which is the *cauda equina*: the dura mater is no farther continued. The nerves that go off from the ſpinal marrow in its courſe are more uniform in ſize than in the quadruped; the parts being more equal, and no extremities, except the fins, to be ſupplied. The ſtructure of the ſpinal marrow is more fibrous than in other animals; when ſeparated longitudinally, it tears with a fibrous appearance, but when ſeparated tranſverſely, it breaks irregularly.

The ſkull is lined with the dura mater, and in ſome forms the three proceſſes correſponding to the diviſions of the brain, as in the human ſubject; but in others this diviſion is bony. Where the dura mater covers the ſpinal marrow, it differs from what takes place in other animals, for it encloſes the marrow cloſely, and the nerves immediately paſſing out through it at the lower part, as they do at the upper, ſo that the cauda equina as it forms is on the outſide of the dura mater.

155 Nerves.

The nerves going out from the brain are ſimilar to thoſe of the quadruped, excepting in thoſe that want olfactory nerves, as the porpoiſe. As the organs of ſenſe are variouſly formed in different animals, fitted for the different modes of impreſſion, in this tribe the conſtruction is varied according to the economy of the animal. The ſenſes of touch and taſte ſeem to be adapted to every mode; but thoſe of ſmell, ſight, and hearing, probably require to be varied or modified according to circumſtances; and according to theſe circumſtances the ſenſes are formed.

156 Skin the ſeat of ſenſation.

Senſe of touch—The ſkin in this tribe of animals appears in general to be well calculated for ſenſation.

The whole ſurface is covered with villi, which are ſo many veſſels, and it muſt be ſuppoſed alſo nerves. Whether this ſtructure be only neceſſary for acute ſenſation, or whether it be neceſſary for common ſenſation, is not known. But it may be obſerved, that where the ſenſe of touch is required to be acute, the villi are uſually thick and long; and this is probably neceſſary, becauſe in theſe parts of the body where the ſenſations of touch are acute, ſuch parts are covered with a thick cuticle. This is remarkably the caſe in the ends of our fingers and toes, and in the foot of the hoofed animals. Mr Hunter ſeems to think that the ſenſe of touch poſſeſſes greater acuteneſs in water.

157 Tongue not merely the organ of taſte.

Senſe of taſte.—The tongue in moſt animals is not only the organ of taſte, but is alſo intended for mechanical purpoſes. For this latter purpoſe it is perhaps leſs ſo than in any other animal. In ſome it has more freedom of motion than in others; and the reaſon of this is probably the difference in the mode of catching the food and of ſwallowing. In thoſe with teeth it projects moſt, which ſeems leſs neceſſary in others which merely open the mouth to receive the food along with the water, or ſwim upon it. In the porpoiſe and grampus, the tongue is firm in texture; but in the ſpermaceti whale it reſembles a feather bed. It is compoſed of muſcle and fat; and in ſome is pointed and ſerrated on the edges.'

158 Wanting in ſome.

Senſe of ſmelling.—In many of this tribe there is no organ of ſmell at all; and in thoſe which have ſuch an organ, it is not that of a fiſh, and therefore, like theirs it is probably not calculated to ſmell water. It becomes a matter of difficulty to account for the manner in which ſuch animals ſmell water, and why others have no ſuch organ, which is ſuppoſed to be peculiar to the large and ſmall whalebone whales. Mr Hunter is of opinion that the air retained in the noſtril out of the current of reſpiration, which by being impregnated with the odoriferous particles contained in the water during the act of blowing, is applied to the organ of ſmell. It might be ſuppoſed, he obſerves, that they would ſmell the air on the ſurface of the water by every inſpiration as animals do on land; but admitting this to be the caſe, it will not give them the power to ſmell the odoriferous particles of their prey in the water at any depth; and as their organ is not fitted to be affected by the application of water, and as they cannot ſuck water into the noſtrils without the danger of its paſſing into the lungs, it cannot be by its application to this organ that they are enabled to ſmell. Some have the power of throwing the water from the mouth through the noſtril, and with ſuch force as to raiſe it 30 feet high. This no doubt anſwers ſome very important purpoſe, although not very obvious. Mr Hunter ſuppoſing that ſmelling the external air could be of no uſe as a ſenſe, thinks that they do not ſmell in inſpiration; for the organ of ſmell is out of the direct road of the current of air in inſpiration, and it is alſo out of the current of water when they ſpout; may it not then be ſuppoſed, he aſks, that this ſinus contains air, and as the water paſſes in the act of throwing it out, that it impregnates this reſervoir of air, which immediately affects the ſenſe of ſmell? This operation is conjectured to be performed in the act of expiration; becauſe then the water is ſaid to be very offenſive. Mr Hunter adds, that if this ſolution be well founded, thoſe only can ſpout which have the organ of ſmell. But as ſome animals of this order are entirely deprived of this organ, and as the organ in thoſe which have it is extremely ſmall, as well as the nerve which receives the impreſſion, it would appear to be leſs neceſſary in them than in thoſe which live in air.

159 Similar to quadrupeds.

Senſe of hearing.—The internal ear in general has nearly the ſame conſtruction as that of quadrupeds. The bones, the cavities, the cartilages, and the nerves are the ſame, their diſpoſition and arrangement varying in ſome of the ſpecies; and from this there ariſes a difference of ſtructure in theſe organs, and perhaps alſo a difference in the ſenſation. According to ſome anatomiſts, the ſemicircular canals are wanting in ſome of this tribe of animals; while they have been deſcribed by others. Some have deſcribed the form of the veſtibulum as in the ſpermaceti whale, others have denied its exiſtence altogether. It is perhaps owing to their being leſs eaſily detected, that they have been ſuppoſed not to exiſt at all. According to the relations of fiſhermen, the cetaceous tribe have the ſenſe of hearing as acute as that of quadrupeds.

160 Is ſmall.

Senſe of ſeeing.—The organ of ſight in this tribe ſeems to have a very cloſe analogy with the ſame organ in quadrupeds. There is the ſame relative connection between the choroid coat, the retina, and the cryſtalline humour. In ſome circumſtances, however, they differ, by which probably the eye in this tribe is better adapted to ſee in the medium through which the light is to paſs. The eye for the ſize of the animal is ſmall; from which it is conjectured that their power of motion is not great. As no obſervations have yet been made on the form, ſize, and denſity of the different humours of the eye, any thing we could add would be mere conjecture founded on vague analogy.

SECT. VI. *Of the Organs of Generation, &c.*

161 Structure ſimilar to thoſe of ruminating animals.

If the cetaceous tribe of animals come near to fiſhes in ſome point of reſemblance, they are very different in thoſe of others. This is remarkably the caſe in the ſtructure of the organs of generation, in which they come nearer in form to thoſe of ruminating animals, than of any other; and this ſimilarity is more ſtriking in the female than in the male; for the ſituation muſt vary in the latter on account of external circumſtances.

162 Male.

In the male the teſticles remain in the ſituation in which they were formed, as in thoſe quadrupeds in which they never come down into the ſcrotum. They are ſituated near the lower part of the abdomen, one on each ſide, upon the two great depreſſors of the tail; and at this part they come in contact with the abdominal muſcles anteriorly. The vaſa deferentia paſs directly from the epididymis behind the bladder, or between it and the rectum, into the urethra. The veſiculæ ſeminales are wanting. The ſtructure of the penis is nearly the ſame as that of the quadruped. The erectores penis, which have a ſimilar inſertion to thoſe of the human ſubject, as well as the acceleratores, are very ſtrong muſcles.

163 Female.

Theſe organs in the female conſiſt of the external opening of the vagina, the two horns of the uterus, Fallopian tubes, fimbriæ, and ovaria. The external opening is a longitudinal ſlit, whoſe edges meet in two oppoſite points, forming a kind of ſulcus. The vagina paſſes upwards and backwards in a diagonal direction, reſpecting the cavity of the abdomen, and then divides into the two horns, one on each ſide of the loins. Theſe afterwards terminate in the Fallopian tubes, to which the ovaria are attached. The inſide of the vagina is ſmooth for about one-half of its length, and then begins to form ſomething ſimilar to valves projecting towards the mouth of the vagina, each like an *os tincæ*. Theſe are from ſix to nine in number. They hardly go quite round where they firſt begin to form, but the laſt make complete circles; and at this place the vagina becomes ſmaller, and continues gradually to decreaſe in width to its termination. From the laſt projecting part the paſſage is continued up to the opening of the two horns; and at this place the inner ſurface forms longitudinal rugæ, which ſtretch into the horns.

The Fallopian tubes, at their termination in the uterus, are for ſome inches remarkably ſmall, they then begin to dilate ſuddenly; and this dilatation increaſes, till at the mouth they are five or ſix inches in diameter. Through their whole length they are full of longitudinal rugæ. The ovaria are oblong bodies about five inches in length; one end is attached to the end of the Fallopian tube, and the other to the horn of the uterus. They are irregular in the external ſurface, and have no capſule but what is formed by the Fallopian tube.

In what poſition the act of copulation is performed, does not ſeem to be preciſely aſcertained. The Greenland fiſhermen ſay, that they are then erect in the water, the heads being above the ſurface, and embracing each other with the fins. M. de St Pierre, during the courſe of a voyage to the Iſle of France, aſſerts, that he ſaw them ſeveral times in this poſition. Others as confidently affirm, that the female throws herſelf on her back; but it would appear that this poſition muſt interfere with the act of reſpiration, which cannot be for any length of time ſuſpended; and, therefore, that it is leſs probable.

164
Bring forth one at a time, once in two years.

It is conjectured, that the female admits the male only once in two years, and that the time of geſtation is nine or ten months. It is probable, too, that having only two nipples, they bring forth only a ſingle young one at a time.

165
Mammæ.

The glands for the ſecretion of milk, or the breaſts, are two, one on each ſide of the middle line of the belly at its lower part. The poſterior ends, from which the nipples proceed, are on each ſide of the opening of the vagina in ſmall furrows. They are flat bodies lying between the external layer of fat and the abdominal muſcles, and are of conſiderable length, but only one-fourth of that in breadth. There is a large trunk which runs through the whole length of the gland, and appears to ſerve the purpoſe of a reſervoir for the milk. Into this trunk the lateral and ſmaller ducts enter, ſome with the courſe of the milk, ſome in a contrary direction. The trunk terminates in a projection externally, which encloſes the nipple.

166
Proceſs of ſucking.

It ſeems difficult at firſt ſight to conceive in what way the proceſs of ſucking is performed; ſo that both the mother and the young one may at the ſame time reſpire freely. According to the relations of the Greenland fiſhermen, the mother throws herſelf on her ſide, and the young one then ſeizes the nipple. In this poſition, the ſmalleſt motion of the body permits the mother or the young one to enjoy the advantage of reſpiration. The art of ſucking muſt be different from that of land animals, for in them it is performed by drawing the air from the mouth backward into the lungs, which the fluid follows by the preſſure of the external air on its ſurface; but, in the cetaceous tribe, the lungs have no connexion with the mouth. The operation of ſucking muſt therefore be performed by the action of the mouth itſelf, and by its having the power of expanſion.

167
Milk rich.

The milk of the whale is ſuppoſed to be very rich. In the one which was taken near Berkeley with its young one, the milk was taſted by Mr Jenner and Mr Ludlow. By their account, it had the richneſs of cows milk to which cream had been added.

The young whale, according to Dudley, continues to ſuck for a year. They are then called *ſhort heads* by the fiſhermen, and are extremely fat, ſome yielding 50 tons of fat. The mothers, at the ſame period, are very lean. At the age of two years, they are called *ſtunts*, becauſe they are ſuppoſed to be dull after being weaned. The quantity of fat which they then yield is from 24 to 28 tons. After this period, they come under the denomination of *ſkull-fiſh*, when their age can only be gueſſed at by the length of hair at the terminations of the whalebone.

168
Affection for its young.

The affection and attachment which the whale diſcovers for its young, have been much celebrated by naturaliſts. Perhaps it is magnified by the compariſon between the whale and fiſhes living in the ſame element, the care of whoſe offspring is totally diſregarded by the parent, and left, which indeed is all that is neceſſary, to the influence of heat and air to bring forth from the ova or ſpawn depoſited by the mother. This attachment is probably, after all, not more remarkable than in other animals which ſuckle their young, and bring forth a ſmall number, or only one at a time.

Sect. VII. *Of the Food of the Whale; the Size, Mode, Fat, &c.*

169
Different kinds of fiſh.

Food.—The food of the whole cetaceous tribe is ſuppoſed by naturaliſts to be fiſh, each probably having ſome particular kind. Some hundreds of the beaks of cuttle-fiſh were found by Mr Hunter, in the ſtomach of the bottle-noſe whale; in the ſtomach of the piked whale, bones of different fiſh, but particularly thoſe of the dog-fiſh; and, in the grampus, the tail of a porpoiſe.

Conſidering the capacity of the œſophagus, we muſt conclude, that they do not ſwallow fiſh ſo large in proportion to their ſize as many fiſh do; for it is obſerved, that fiſh often attempt to ſwallow more at a time than what the ſtomach will hold; ſo that part muſt remain in the œſophagus till the reſt is digeſted.

170
Of the large whale.

The food of the large whalebone whale is ſuppoſed to be ſmall fiſh, ſometimes crab-fiſh and ſhell fiſh. It may appear ſtrange, that ſo large an animal ſhould be able to find a quantity of food ſufficiently great for its ſubſiſtence, and to preſerve with it ſuch a covering of fat as they are generally found to have. But this wonder ceaſes, when it is conſidered that the very food they ſeek after, is found in the greateſt abundance in thoſe regions which they uſually inhabit. In the economy of the whalebone whale, this ſubſtance, from which it derives its name, ſeems to be of particular uſe; for as it appears that they live on ſmall fiſh, which they probably receive into the mouth in great numbers, it was neceſſary that there ſhould be ſome contrivance to retain them in the mouth till they are ſwallowed; and this purpoſe is fully anſwered by the whalebone.

171 Northern whale. The northern whale, or the north-caper, lives on mackerel, herrings, cod fiſh, and tunny-fiſh. Horrebow mentions, that the Icelanders found in the ſtomach of an individual of this ſpecies, which came on ſhore in purſuit of its prey, no leſs than 600 living cod-fiſh, beſides a great number of pilchards, and ſome aquatic birds. This account is probably exaggerated, at leaſt with regard to the number of fiſh in the ſtomach being alive. The other ſpecies belonging to this genus uſually feed on the herring, the arctic ſalmon, and the ſand eel.

172 Narhwal. The narhwal, or unicorn whale, is ſaid to live chiefly on the different ſpecies of actinia. It is unprovided with teeth to ſeize its prey; but, according to ſome naturaliſts, it can employ the long tooth which proceeds from the upper jaw to entangle theſe fiſhes; and having collected them in this manner to the edge of the lips, it ſucks them into the mouth and deſtroys them, by conſtantly ſtretching the tongue along the lips.

173 Spermaceti whale. The ſpermaceti whales purſue the ſeal, the dolphin, and the pike-headed whale. The large ſpermaceti whale purſues, with great avidity, the ſhark, which is ſaid to be his ordinary food; and this animal, otherwiſe ſo formidable, is ſeized with ſuch a panic at the ſight of this terrible enemy, that he conceals himſelf in the mud, or under the ſand; ſometimes ſeeing himſelf ſo aſſailed on all ſides, he darts acroſs the rocks, and ſtrikes them with ſuch force and violence as to occaſion his own death. This terror, according to Fabricius, is ſo ſtrongly impreſſed, that the ſhark, which is ſo greedy of the carcaſes of the other cetaceous fiſhes, dares not even approach the dead body of the large ſpermaceti whale.

174 Blackheaded ſpermaceti whale. The phyſeter microps is ſaid to prey chiefly on the ſeal. When the ſeals are in numbers together, and find themſelves attacked by their enemy, they make a precipitate retreat. Some gain the ſhore; while others climb on a piece of ice; and then, if the whale be alone, he conceals himſelf under the ice, and waits till the ſeal return to the water, when he ſeizes his prey. But if ſeveral whales have joined in the purſuit, as frequently happens, it is ſaid that they ſurround the maſs of ice, and overturn it in the water.

175 Dolphin. The dolphin genus feed on cod-fiſh, flat fiſh, ſuch as the turbot, and many other kinds of fiſh of moderate ſize. The grampus is the boldeſt, the ſtrongeſt, and the moſt voracious of any belonging to this tribe of animals. It is agreed by almoſt all naturaliſts, that the grampus will even attack the great whale and put him to flight, which is ſaid to be the reaſon that they are ſometimes thrown aſhore on our coaſts.

176 60 feet. *Size of the whale.*—The whale is now rarely ſeen to exceed 60 feet in length, by 36 feet in circumference. A whale, which landed in the iſland of Corſica in 1620, was one of the largeſt which has been known for ſome centuries. It meaſured 100 feet in length. But although this be an enormous bulk, it falls far ſhort of the magnitude of the whale, as it has been deſcribed by ancient naturaliſts, exiſting in their time. But probably theſe relations will gain little faith, even from the moſt credulous of the preſent day, in which Pliny ſpeaks of the whale being 960 feet long; and in another place, the ſame naturaliſt ſays, that Juba writes to C. Cæſar, the ſon of Auguſtus, that ſome whales of 600 feet in length, and 360 in circumference, had entered the rivers of Arabia.

But whatever credit is to be given to theſe ſtories, 177 Formerly larger.
there is little doubt that the whales in the northern
ocean were formerly of much greater bulk than they
now are; and the reaſon ſeems to be, that being leſs
diſturbed when this fiſhery was leſs frequented, they 178 Reaſon.
arrived at a greater age, and conſequently acquired a
greater ſize.

179 More frequent in the ocean formerly. *Abode of the whale.*—According to the teſtimony of the ancient naturaliſts, the whale was more frequently ſeen in the ocean than at preſent; for, on account of being diſturbed by the numerous fleets traverſing the ocean, they have retired to the regions of the north, where they are leſs expoſed to the noiſe of the mariners, leſs haraſſed by the fiſhermen, and enjoy that tranquillity which is no longer to be found in their former haunts.

180 Chiefly in the northern ſeas. The large whalebone whale is moſt frequently found in the Greenland ſeas, Davis ſtraits, and the coaſts of Spitzbergen, Iceland, and Norway; on the coaſts of Labrador, in the gulf of St Lawrence, and round Newfoundland. This whale is alſo found among the Philippine iſlands, near Socotora, an iſland on the coaſt of Arabia Felix, and on the coaſts of Ceylon. The whale alſo frequents the Chineſe ſeas; and, if the reports of voyagers are to be implicitly admitted, is found there of an immenſe ſize. The uſual retreat of the ſpermaceti whale is the northern ocean, towards Davis ſtraits, the North Cape, and the coaſts of Finmark. Of all the cetaceous fiſh, this indeed ſeems to lead the moſt wandering life. In the year 1787, this whale was diſcovered in great numbers in an extenſive bay on the ſouthern peninſula of Africa, at the diſtance of 40 leagues from the Cape of Good Hope.

The dolphin family is found in all ſeas; in the ocean, the Mediterranean, the gulf of Meſſina, and the Adriatic ſea, from whence they go into the lagoons of Venice, and to the coaſts of Galicia. On the coaſts of Cochin-China very conſiderable fiſheries are eſtabliſhed, which produce a great quantity of oil.

181 Largeſt fiſhes in northern regions.
We may conclude, that, in general, the great whale
and the unicorn-fiſh uſually frequent the ſeas towards
the poles, between the 68th and 79th degrees of latitude;
and that the other families are found diffuſed
more or leſs in the ſeas of more temperate regions. It
would appear, from this account of the places which
are the ordinary haunt of the whale, that the productions
of nature are diſpoſed ſomewhat in a contrary 182
order; ſince we find all the large terreſtrial animals, Largeſt land animals in the torrid zone.
ſuch as the elephant and rhinoceros, in countries within
the torrid zone; while the huge inhabitants of the
ocean have fixed their abode in the polar regions.

183 Cauſes of.

Migration of the whale.—Although the abode of the whale be generally determined and fixed, yet particular cauſes force them to leave their uſual and natural haunts. The ſeaſon of their amours, a furious ſtorm, the purſuit of a haraſſing enemy, the want of food, or exceſſive cold, often oblige them to migrate. Sometimes they appear ſolitary, ſometimes in conſiderable numbers, according to the nature of the cauſes which have diſturbed and driven them from their ordinary retreats. According to the information of voyagers who have viſited theſe regions, the great whale every year, in the month of November, leaves Davis ſtraits, enters the river St Lawrence, and there brings forth her young, between Camouraſca and Quebec; and from thence, in the month of March following, they regularly return to the polar ſeas.

It appears, that the whale conſtantly remains in the northern ocean, and never leaves it but when the female is to bring forth, or when they are driven away by an enemy. In this laſt caſe they are moſt commonly found ſolitary, at leaſt not more than the male and female, or the mother and the young one.

The ſpermaceti whales, however, ſeem frequently to change their habitation, and to roam about in ſtrange ſeas. This appears from conſiderable numbers having been thrown aſhore or left dry by the retreating tide at different times. In the year 1690, 200 of this ſpecies were landed near Cairſton in the Orkneys; and, in the year 1784, 31 large ſpermaceti whales came on ſhore on the weſt coaſt of Audierne in Lower Brittany in France.

184 Black-headed whale.

Enemies of the whale.—The greateſt and moſt terrible enemy of the ſmall whale is the phyſeter microps, or black-headed ſpermaceti whale. As ſoon as he perceives the pike-headed whale, the porpoiſe, and ſome others, he darts upon them, and tears them to pieces with his crooked fangs.

185 Unicorn-fiſh.

It is ſaid, that there exiſts a continual and ſettled enmity between the unicorn-fiſh and the great whale; and that they never meet without engaging in combat, in which the whale receives ſo many ſevere, and often deadly wounds, as often to occaſion its death. When the unicorn-fiſh ſtrikes its tooth or horn into the ſide of ſhips, it is ſuppoſed that it is through miſtake, taking the veſſel for its enemy, the whale.

186 White bear.

The white bear, ſo common in Greenland and Spitzbergen, is extremely fond of the fleſh of the cetaceous and other fiſhes. He remains conſtantly on the watch for his prey on a maſs of ice, or on the ſea ſhore; and as ſoon as he perceives it, he throws himſelf into the water, and plunges to attack it. The large and the ſmall whales are equally the objects of his eager purſuit; but he is not ſucceſsful till after they have loſt a great deal of blood from the wounds which he has inflicted, or they have been exhauſted with fatigue.

187 Saw-fiſh.

Between the ſaw fiſh and the whale there exiſts a conſtant warfare. It is related by all the fiſhermen, that the whale and ſaw-fiſh, whenever they meet, join in combat, and that the latter is always the aggreſſor. Sometimes two or more individuals combine to attack a ſingle whale; and it is inconceivable with what fury they make the attack. The whale, whoſe only defence is his tail, endeavours to ſtrike his enemy with it; and a ſingle blow would prove mortal. But the ſaw-fiſh, with aſtoniſhing agility, ſhuns the dreadful ſtroke, bounds into the air, and returns upon his huge adverſary, plunging the rugged weapon, with which he is furniſhed, into his back. The whale is ſtill more irritated by this wound, which only becomes fatal when it penetrates the fat. The engagement ceaſes not but with the death of one of the combatants. Martens relates an account of one of theſe combats between the Iceland whale (Balæna Glacialis) and the ſaw fiſh. It ſeemed to be extremely dangerous to approach the field of battle. It was therefore at ſome diſtance, that he ſaw them purſuing and ſtriking each other, dealing ſuch violent blows that the water roſe in foam as if agitated by a ſtorm. He was prevented from ſeeing the iſſue of the ſtruggle by the weather becoming thick and hazy; but he was informed by the ſailors, that ſuch combats were frequent; that they generally kept at a diſtance till the whale was vanquiſhed; and that the ſaw-fiſh, only eating the tongue, relinquiſhed the reſt of the body, which they take poſſeſſion of.

Forſkal informs us, that the Arabians believe that ſome ſpecies of the ſcarus, a fiſh found in the Red ſea, enter the blow-holes of the whale, and deſtroy it with their ſharp ſpines; and, in confirmation of this fact, it is mentioned, that one of theſe fiſhes was found in the blow-hole of a dead whale.

188 Birds.

The whale is even haraſſed with aquatic birds, which alight in great numbers on his back, in ſearch of the teſtaceous animals and ſmall inſects, which have made it their habitation. And, like moſt other animals, the whale is tormented with a ſpecies of louſe, peculiar to itſelf, which adheres ſo ſtrongly to the ſkin, that it may be ſooner torn aſunder than be made to let go its hold. The fins, the lips, the parts of generation, and other parts of the body, which are moſt protected from friction, are chiefly infeſted with this inſect. The bite is extremely painful, and they are moſt troubleſome in that ſeaſon when the whale is in heat.

189 Not ſo old as formerly.

Age of the whale.—If the time neceſſary for the growth or increaſe of the body were in proportion to the period of life, there could be little doubt of the whale being, of all animals known, the moſt remarkable for longevity. It is well known, that the whales which were taken when this fiſhery firſt became an object of trade, that is, between 200 and 300 years ago, were of much greater bulk than they are found to be in the preſent day. The largeſt now taken rarely exceed 60 feet long; while, at that time, ſome reached the aſtoniſhing ſize of 100 in length. The reaſon of this difference of ſize ſeems to be, that, when the fiſhery firſt commenced, whales, which had probably reached their utmoſt growth, were frequently met with. Theſe, on account of being the largeſt, were conſtantly haraſſed, purſued, and deſtroyed; ſo that none which have obtained their full growth are now to be found in thoſe ſeas reſorted to by the fiſhermen. From this circumſtance, that no large whales are now to be ſeen in the places which they commonly frequent, it is concluded, that the period of the life of the whale is very long; and that they cannot arrive at the huge ſize for which the firſt whales were ſo remarkable, ſince they are not permitted to live undiſturbed the requiſite length of time to attain that bulk. According to Buffon, a whale may live 1000 years, ſince a carp has been known to reach the age of 200.

But, reaſoning from analogy, with regard to the ſtructure and economy of the whale, we have ſeen in many inſtances, by no means holds; and it is perhaps equally inapplicable to the growth and age of this order of animals.

190 Oil.

The fat or oil of cetaceous fiſhes.—The fat of this order of animals is uſually called *oil.* It is the moſt fluid of animal fats, for it does not coagulate in our atmoſphere. It is found in conſiderable quantity, principally on the outſide of the muſcles, and immediately under the ſkin; and is rarely to be met with in any of the cavities, or in the interſtices of the muſcles. This ſubſtance is encloſed in a reticular membrane, apparently compoſed of fibres paſſing in all directions, which ſeem to confine its extent, and allow it little or no motion on itſelf; for the whole, when diſtended, forms almoſt a ſolid body. In ſome of the animals of this order there is a different diſtribution of the fat. Under the head or neck of the bottle noſe whale, it is confined in large cells which admit of motion. In ſome this reticular membrane is very fine, in others it is coarſe and ſtrong, and it varies in different parts of the ſame fiſh. In the porpoiſe, ſpermaceti, and large whalebone whale, it is very fine; in the grampus and ſmall whalebone whale, it is coarſe. In all of them it is fineſt on the body, becoming coarſer as it reaches and covers the fins and tail, which latter is compoſed of fibres without any fat.

The internal fat is the leaſt fluid in this order of animals. It is nearly of the conſiſtence of hogs lard. The external fat is the common train-oil. It is the adipoſe covering from all of the whale kind, which is brought home in ſquare pieces called *flitches*; and this, which is commonly known under the name of *blubber*, after being boiled, yields the oil by expreſſion, leaving the cellular membrane. 191 Of two kinds. When theſe flitches or maſſes of fat become putrid, there iſſue two kinds of oil. The one is pure; but the other ſeems to have a conſiderable mixture of other animal matters, which, from the ſtate of putridity, are readily diſſolved in the purer oil, and form a kind of butter. It feels unctuous to the touch, and ropy, coagulates with cold, ſwims on water, and the pure oil ſeparates and riſes to the top. The ſubſtance which remains after all the oil is extracted, is almoſt entirely convertible into glue, and is ſold to be applied to the ſame purpoſes.

192 In every part of the body.

Spermaceti.—The ſubſtance called *ſpermaceti*, is found in every part of the body, mixed with the common fat of the animal; but to this it bears a ſmall proportion. In the head this ſubſtance is alſo mixed with the common fat; but here the proportions of the two ſubſtances are reverſed: the ſpermaceti is by far in greateſt quantity. 193 Moſt abundant in the head. And, from this circumſtance of its being found in ſuch abundance, in what, from a ſlight view, would appear to be the cavity of the ſkull, it has been by ſome ſuppoſed to be the brain.

The two kinds of fat in the head are contained in cells or in cellular membrane, ſimilar to what takes place in other animals; but, beſides theſe, there are larger cells, or ligamentous parts going acroſs, the better to ſupport the vaſt load of oil of which the bulk of the head is principally compoſed. There are two places in the head in which this oil lies. Theſe are ſituated along the upper and lower part of it, and are divided by the noſtrils and a great number of tendons which paſs from the noſe and the different parts of the head. The cells, which are of the ſmalleſt ſize, and are the leaſt ligamentous, are obſerved to contain the pureſt ſpermaceti. Theſe cells reſemble thoſe which contain the fat in other parts of the body neareſt the ſkin, and they lie above the noſtril, along the upper part of the head, immediately under the ſkin and common cellular membrane. The ſpermaceti, which lies above the roof of the mouth, or between it and the noſtril, is more intermixed with a ligamentous cellular membrane; and it is contained in chambers whoſe partitions are perpendicular. Near the noſe theſe chambers are ſmalleſt; but they become larger towards the back part of the head, and in theſe laſt the ſpermaceti is pureſt. About the noſe Mr Hunter diſcovered a great number of veſſels which had the appearance of a plexus of veins, ſome of which were as large as a finger. They were loaded with ſpermaceti and oil, and ſome of them had correſponding arteries. He thinks it probable that they were lymphatics, and that their contents were abſorbed from the cells of the head; for many of theſe cells or chambers were found empty.

The numerous uſeful purpoſes to which the common oil of the whale and the ſpermaceti are applied, the latter ſometimes in medicine, and both in many of the arts and in domeſtic economy, are too well known to be particularly pointed out.

194 Doubts and opinions of its origin.

Ambergris.—This ſubſtance, the origin of which was long a matter of doubt and uncertainty among naturaliſts, is now pretty well aſcertained to be the production of ſome of the cetaceous tribe of animals. By ſome it was ſuppoſed to be the excrement of the whale, and, by others, that it was the dung of birds. According to ſome, it is compoſed of honey and wax, conſolidated by the heat of the ſun and the action of ſea water; while, in the opinion of others, it is a bituminous ſubſtance, which flows from the bowels of the earth into the waters of the ocean, where it becomes hard and firm.

195 The production of the ſpermaceti whale.

But, in the opinion of later naturaliſts, it is a ſubſtance which has an origin and formation ſimilar to that of muſk, and is a production of the ſpermaceti whale. This opinion has been rendered more probable by the ſame ſubſtance having been found in ſome whales of this ſpecies, and particularly in one which came on ſhore on the coaſt of Bayonne in France, in 1741. In the latter it was found in rounded maſſes from three to 12 inches in diameter, which weighed from 1½lb. to 20lb. It was contained in an oval bag from three to four feet long, and from two to three feet broad, which was ſuſpended immediately above the teſticles. This bag terminated in two tubes, one of which becoming narrower, reached to the penis; the other proceeded from the kidneys, and terminated in the other extremity. The bag was almoſt entirely filled with a yellow-coloured fluid, not quite ſo thick as oil, exhaling a ſimilar but ſtronger odour than the maſſes of ambergris which floated in it. Each maſs was compoſed of concentric layers. The number of maſſes found in one bag never exceeded four. One was found which weighed 20lb.; but there was no other in the ſame bag. It has been ſuppoſed that the ambergris is only found in old whales, and in the males. Some naturaliſts think that this ſubſtance is an oily concretion

tion which exhales the odour of the fluid in which it is formed; and that the bag which contains theſe fragrant maſſes is the urinary bladder.

But if this be the uſual mode in which ambergris is produced, it appears difficult to account for the large maſſes which are found floating in the waters of the ocean in different parts of the world, as among the iſlands in the torrid zone, and in the Indian and African ſeas.

According to the information collected by Dr Swediaur, and which the reader will find more fully detailed under the word Ambergris, it appears that it is generally conſidered by the New England fiſhermen as a production of the ſpermaceti whale. Sometimes they find it floating in the ſea; and when this happens, they ſearch for the whale, ſuppoſing that it has been voided by this animal. Sometimes they cut it out from a ſwelling or protuberance on the belly of the dead whale. And from all the information which Dr Swediaur could obtain, he concludes, that ambergris is generated in the bowels of the ſpermaceti whale (*Phyſeter Macrocephalus*, Lin.), and that it is there mixed with the beaks of the *ſepia octopodia*, which is the principal food of this whale. He therefore conſiders this ſubſtance to be the fæces of the animal preternaturally indurated, mixed with the indigeſtible relicks of the food. See Ambergris.

196 Suppoſed to be indurated fæces.

Later information has verified ſome part of the doctor's opinion, as well as ſome of the conjectures of earlier naturaliſts. Mr Coffin, maſter of a ſhip employed in the ſouthern whale-fiſhery, brought home in the year 1791, 362 ounces of ambergris taken from the body of a female ſpermaceti whale on the coaſt of Guinea. Part was found floating in the ſea, and part was ſeen coming from the anus while the people were employed in cutting up the blubber. More was found in the inteſtines, and the reſt in a bag communicating with them. This whale was lean, ſickly, and old, and yielded but a ſmall proportion of oil. When the ſpermaceti whale is ſtruck, ſhe generally voids her excrement; and, if ſhe does not, it is conjectured that ſhe has no ambergris. Mr Coffin ſuppoſes, that the production of this ſubſtance is either the cauſe or the effect of ſome diſeaſe, as he thinks it is moſt likely to be found in ſickly fiſh, as was the caſe with the fiſh which yielded him ſo large a quantity. Perhaps it may be found by future and more accurate inveſtigation to be a natural production of the animal, ſecreted to anſwer ſome important purpoſe in its economy; and that it is preternaturally increaſed in quantity, either by the exceſſive or the diminiſhed action of the vital powers in age or diſeaſe, and then it is excreted, or diſcovered in the body of the fiſh after death.

197 Probably a preternatural ſubſtance.

198 Uſed as a perfume.

Ambergris is one of the moſt fragrant perfumes; and for this purpoſe it is chiefly employed in this as well as in moſt other countries. In Aſia, and in ſome parts of Africa, it is alſo uſed in medicine and cookery. It is bought up in conſiderable quantities by the pilgrims who travel to Mecca, by whom it is ſuppoſed to be uſed in fumigations in religious ceremonies, in the ſame manner as the burning frankincenſe or other fragrant perfumes makes part of the religious rites of other countries.

Chap. III. *Of the Whale-Fiſhery.*

199 Power of man in ſubduing the largeſt animals.

Nothing, perhaps, diſplays in a more ſtriking manner the power and dexterity of man than the facility and ſucceſs with which he conquers and deſtroys the moſt enormous and the moſt formidable of the animated productions of nature. The elephant and the whale, the largeſt animals known, the one ſeemingly ſecure in the midſt of the huge icy mountains of the polar regions, and the other roaming at pleaſure in the almoſt inacceſſible wilds and deep woods of the torrid zone, yield to his power or fall beneath his all-ſubduing arm. The ſwifteſt and the moſt ferocious, as well as the moſt ſagacious, and the moſt cunning and artful, eſcape not the toils and ſnares which he contrives, or the deadly aim of the inſtruments of his invention.

Whether man was originally urged by neceſſity, as is moſt probable, to attack ſo huge a monſter as the whale, or whether it was indirectly to gratify the artificial demands of luxury that he firſt attempted and ſtill continues to perſevere in an occupation ſo full of danger and fatigue, it muſt be allowed to be one of the boldeſt and moſt daring enterpriſes that can be conceived. And indeed were it not quite familiar to us, we ſhould ſtill behold with dread and aſtoniſhment ſo feeble a creature as man preparing to attack this monſter of the deep, whoſe ſtrength, were it properly directed, no power could reſiſt; nor would our wonder be diminiſhed, when we find that he ſeldom fails to ſucceed in the attempt. But knowledge is power; and the triumphs of intellectual power are equally conſpicuous, in accommodating the moſt unwieldy and moſt unmanageable parts either of the inanimate or animated creation to the ſupply and gratification of human wants and deſires, in guiding through the trackleſs ocean, the ſhip from which the ſpear is launched for the deſtruction of the whale, or in digging from the bowels of the earth the metal with which the compaſs and the harpoon are conſtructed.

200 Norwegians firſt acquainted with this fiſhery.

So early as the 9th century, in the time of Alfred the great, it appears that the Norwegians were acquainted with the whale-fiſhing. This prince received an account of the diſcoveries of a Norwegian about the North Cape, in which he ſpeaks of his having been as far north as the places to which the whale-hunters reſort; which is conſidered as a proof of its antiquity; although it is ſuppoſed that it was purſued merely on account of the oil, the uſe of the whalebone not being then known *.

201 Biſcayans moſt expert.

But the people who are recorded in hiſtory as having proſecuted this fiſhery with ſucceſs, were the Biſcayans. The ſpermaceti whale, as well as the whalebone whale, were at that time frequently ſeen in theſe latitudes. The firſt attempts were made in the bay of Biſcay, and in the gulf of Gaſcony. Ships were fitted out, inſtruments were conſtructed, and an eſtabliſhment was formed for carrying on the fiſhery. It was obſerved that the whale only appeared at certain ſeaſons of the year, which led the new fiſhers to ſuppoſe that his reſidence in other ſeas was more permanent. And diſcovering that they retreated towards the polar regions, ſhips were fittted out and manned with

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* *Anderſon's Hiſt. of Comm.* i. 84.

with the moſt experienced ſeamen, to purſue them northward. At this time the Biſcayans carried on this trade, both for the ſake of the oil and the whalebone.

202 The Engliſh firſt engage in it.

Towards the end of the 16th century, the Engliſh firſt engaged in the whale-fiſhery. But at this time they were ſo little acquainted with it, that “ the requeſt of an honeſt merchant, by letter to a friend of his, to be adviſed and directed in the courſe of killing the whale,” is recorded by the hiſtorians of that age. The anſwer was, that a ſhip of two hundred tons muſt be fitted out, and provided with all kinds of proper utenſils and inſtruments. But it appears to have been neceſſary to ſend to *Biſkaie for men ſkilful in catching the whale and ordering of the oil, and one cooper ſkilful to ſet up the ſtaved caſk.*

Hakluyt's Voyage, i. 414.

In the year 1594, ſome Engliſh ſhips made a voyage to Cape Breton, at the entrance of the bay of St Lawrence, ſome for the morſe-fiſhing, and others for the whale-fiſhing. This ſeems to have been among their firſt attempts in this trade. The fiſhing proved unſucceſsful; but they found in an iſland 800 whale fins or whalebone, part of the cargo of a Biſcayan ſhip wrecked there three years before, which they put on board and brought home. This was the firſt time that this ſubſtance was imported into England.

203 Whalebone firſt introduced.

204 Ships fitted out from Hull.

The town of Hull, in 1598, firſt fitted out ſhips from England for the Greenland whale-fiſhery, a branch of trade which has ſince become very conſiderable, and has frequently received the protection and encouragement of the legiſlature. A premium of ſix ſhillings for each ton of oil, and five ſhillings for each ton of whalebone, was at firſt granted by government in 1672. But this encouragement appearing inſufficient for the ſucceſs of the fiſhery, or the enterpriſe being conſidered too great for the ſtock of individuals, a company was incorporated in 1692, and eſtabliſhed by royal authority, with peculiar privileges. Their capital amounted to 40,000l. ſterling. The ſubſcriptions in a few years increaſed to 82,000l. ſterling; but in 1701 the company was diſſolved, and the trade made free to all adventurers.

205 Premium granted.

206 Company eſtabliſhed.

207 Engliſh very ſucceſsful.

The Engliſh were now become the moſt ſucceſsful adventurers in this fiſhery. By their ſkill, their induſtry, and perſeverance, and the aid and encouragement granted by the legiſlature, they carried on the whale-fiſhery on more advantageous terms than the Biſcayans the firſt adventurers, whoſe efforts became leſs enterpriſing, as their ſucceſs was more precarious. In the year 1730, they fitted out for this fiſhery only 33 ſhips; about the year 1735, the number was diminiſhed to ten or twelve; and continuing to decreaſe till the war in 1744, the trade was finally abandoned.

208 New Engliſh Company.

The Engliſh ſtill perſevered in the trade, a new company was eſtabliſhed and a fund of 50,000l. ſterling was provided, with power to the company to make all neceſſary and proper regulations. And for the farther encouragement of the fiſhery, a duty of 17l. or 18l. ſterling was impoſed on the ton of all oil imported, and a premium or bounty, to the ſame amount, was paid for every ton of oil exported which was the produce of the national fiſhery. Other encouragements were alſo given; rewards were beſtowed on the moſt ſucceſsful; the ſailors employed in the trade were exempted from the impreſs ſervice; adventurers were indemnified for all loſſes which they ſuſtained in their firſt enterpriſe; and they were granted the privilege of providing, duty free, all thoſe articles which were needed in this fiſhery, and were the ſubjects of taxation.

209 Fiſhery encouraged.

Still farther to encourage and extend the fiſhery, which now had become an important national concern, parliament granted in 1779 a premium to five ſhips which ſhould bring home the greateſt quantity of oil; for the firſt greateſt quantity, 500l. ſterling; for the next, 400l.; and for the third, fourth, and fifth, 300l. 200l. and 100l. ſterling.

210 Fiſhery in North America.

In North America, while that continent was ſubject to Britain, the whale-fiſhery was carried on to a very conſiderable extent. A ſociety was eſtabliſhed at New York, and numbers of ſhips were equipped for this trade in different parts of the colonies, by enterpriſing adventurers, and it has been long extremely ſucceſsful and lucrative.

211 Advantages of the fiſhery.

The advantages derived to the nation from the whale-fiſhery, are no doubt very conſiderable. Beſide being an excellent nurſery for hardy ſeamen, it is the foundation of great commercial concerns, by introducing articles which become the ſources of an important trade. In this view it has often been an object of legiſlative diſcuſſion, and has often experienced the liberal encouragement and protection of government. According to a law paſſed in favour of ſhips employed in this trade, every Britiſh veſſel of 200 tons or upwards, bound to the Greenland ſeas, on the whale-fiſhery, if found to be duly qualified agreeable to the act, obtained a licence from the commiſſioners of the cuſtoms to proceed on ſuch voyage; and on the ſhip's return, the maſter and mate declaring on oath that they were on ſuch voyage, that they uſed all their endeavours to take whales, and that all the whale fins, blubber, oil, &c. imported in their ſhip, were taken by their crew in thoſe ſeas, there was allowed 40s. for every ton according to the admeaſurement of the ſhip.

212 Regulations.

It was afterwards found, however, that ſo great a bounty was neither neceſſary to the ſucceſs of the trade, nor expedient with regard to the public. In 1786, therefore, the acts conferring the ſaid emoluments being upon the point of expiring, the ſubject was brought under the conſideration of parliament; and it was propoſed to continue the former meaſures, but with a reduction of the bounty from 40s. to 30s. In propoſing this alteration, it was ſtated, “ that the ſums which this country had paid in bounties for the Greenland fiſhery amounted to 1,265,461l.; that, in the laſt year, we had paid 94,858l; and that, from the conſequent deduction of the price of the fiſh, the public at preſent paid 60 per cent. upon every cargo. In the Greenland fiſhery there were employed 6000 ſeamen, and theſe ſeamen coſt government 13l. 10s. per man per annum, though we were never able to obtain more than 500 of that number to ſerve on board our ſhips of war. Beſides, the vaſt encouragement given to the trade had occaſioned ſuch a glut in the market, that it was found neceſſary to export conſiderable quantities; and thus we paid a large ſhare of the purchaſe money for foreign nations, as well as for our own people, beſides ſupplying them with the materials of ſeveral important manufactures.” This propoſition was oppoſed by ſeveral members, but was finally carried; and the propriety of the meaſure became very ſoon

213 State of the trade in England.

Whale-Fiſhery.

ſoon apparent. At that time (1786) the number of ſhips employed from England in the whale-fiſhery to Davis ſtraits and the Greenland ſeas amounted to 139, beſides 15 from Scotland. The propoſed alteration took place the following year (1787); and notwithſtanding the diminution of the bounty, the trade increaſed; the number of ſhips employed the ſame year from England amounting to 217, and the next year (1788) to 222. Their cargoes conſiſted of 5989 tons of clean oil; 7654 tons of whalebone, beſide 13,386 ſeal ſkins.

214 Southern whale-fiſhery

For ſome years Britiſh capital has been employed in a ſouthern whale-fiſhery; and this has alſo been a very lucrative branch of trade. This fiſhery was firſt proſecuted with vigour about the commencement of the American war. In the year 1785, 18 ſhips which produced 29,000l. ſterling were employed in it. Two years afterwards the number of ſhips was doubled, and the returns increaſed in a much greater proportion, which is a proof of the flouriſhing ſtate of the trade. The number of ſhips in 1787 was 38, and the produce amounted to 107,000l. ſterling.

215 carried on by Americans ſettled in Milford Haven.

Some American families, when the war broke out in that country, emigrated to Nova Scotia, where they propoſed to carry on the whale-fiſhery; but being diſcouraged from particular circumſtances, on the invitation of the honourable Mr Greville, they ſettled at Milford in Milford Haven, and fitted out a ſhip, which had a very ſucceſsful voyage. The number of ſhips ſoon increaſed to four, and at preſent (1803), that number is doubled, ſo that 18 ſhips are now employed in ſouthern whale-fiſhery from this port, with a capital afloat of no leſs than 80,000l. ſterling. This fact is ſtated by Mr Barrow in his travels in ſouthern Africa; and "I mention it, (ſays he), as a ſtriking inſtance to ſhow the importance of the ſouth-ſea fiſhery, and as a proof that, contrary to the generally received opinion, it may be carried on by ſkill and management, and without the adventitious aid of trading, ſo as fully to anſwer the purpoſe of thoſe who are properly qualified to embark in the undertaking. For where men, by induſtry in their profeſſion, riſe from ſmall beginnings into affluence, ſuch profeſſion may be followed with a greater certainty of ſucceſs than many others which appear to hold out more ſeducing proſpects. The American fiſhermen never ſet out with a capital, but invariably work themſelves into one; and the ſouth-ſea fiſhery from England may ſucceed on the ſame principle, as the above example clearly ſhews, under every diſadvantage, when properly conducted.

216 Partially encouraged.

"It is difficult to point out the grounds of juſtice or policy in giving tonage bounties to the Greenland fiſhery, and only premiums to ſucceſsful adventurers in the ſouthern fiſhery. A voyage to Greenland is four months, the outfit of which is covered by the tonage bounty, and, if wholly unſucceſsful, the ſame ſhip can make a ſecond voyage the ſame year to ſome of the ports of the Baltic. A voyage to the South ſea is from 12 to 18 months, and muſt depend ſolely on the ſucceſs in fiſhing. A Greenland ſhip ſets out on a ſmall capital, and builds on a quick return; but a ſouth-ſea whaler muſt expend a very conſiderable capital in making his outfit, for which he can reckon on no returns for at leaſt 18 months. Hence the uſual practice of ſending them out in the double capacity of fiſhers and contraband traders, in order that the loſſes they may ſuſtain by ill ſucceſs in fiſhing may be made good by ſmuggling.

Whale-Fiſhery.

"If by extending the fiſhery we ſhould be enabled to ſupply the continent of Europe, two objects ſhould never be out of the view of the legiſlature—the exemption from duty of all the produce of the fiſheries, and particularly ſpermaceti, which, if manufactured into candles, and ſubject only to the ſame duty as tallow candles, would produce much more to the revenue than when taxed as it now is, as wax. I have heard it aſſerted that the extenſion of the premium ſyſtem, by doubling its preſent amount, which never could exceed 30,000l. a-year, would be adequate encouragement to ſupply the home-market with ſpermaceti and black whale oil, and that the bonding of foreign oil in Great Britain would throw the whole agency of American fiſhery on England with greater advantage to both countries than by any other ſyſtem.

217 Cape of Good Hope a convenient ſtation.

"But when we conſider that the home market is neceſſarily ſecured to Britiſh ſubjects by high duties on foreign oil, we ſhould alſo conſider that every means to leſſen the charges of outfit ſhould ſtrengthen our adventure in this lucrative branch of trade. Among others that would ſeem to have this tendency, are the facilities that might be afforded by the happy poſition of the Cape of Good Hope. If at this ſtation was eſtabliſhed a kind of central depot for the ſouthern whale-fiſhery, it might, in time, be the means of throwing into our hands excluſively the ſupply of Europe with ſpermaceti oil. To the protection of the fiſheries on the eaſt and weſt coaſts of ſouthern Africa, the Cape is fully competent, and the fiſheries on theſe coaſts would be equally undiſturbed in war as in peace. From hence they would, at all times, have an opportunity of acquiring a ſupply of refreſhments for their crews, and of laying in a ſtock of ſalt proviſions at one fourth part of the expence of carrying them out from England."

218 Dutch early engaged in the fiſhery.

The Dutch were very early engaged in the Greenland whale-fiſhery, which ſoon became one of the moſt important objects of their trade. In 1611 a company was eſtabliſhed in Amſterdam for carrying on the whale fiſhery on the coaſts of Spitzbergen and Nova Zembla. This branch of trade has in general ſucceeded better with the Dutch than with any other nation. The principal reaſon which has been aſſigned for this ſucceſs is the greater economy and frugality of this people, in this as in all their concerns, by which they are able to underſell others in oil and whalebone. The mode of fitting out all their ſhips is alſo mentioned as a cauſe of their proſperity in this fiſhery. The ſhip-builder, the rope-maker, the baker, the brewer, and other tradeſmen, employed in fitting out theſe ſhips, commonly take a ſhare in the voyage. When it proves fortunate, they are double gainers; but when it is unſucceſsful, the loſs which they ſuſtain is probably not greater than if they had merely furniſhed the articles without having a chance of the profit; and in this reſpect have the advantage of mere merchants. It is obſerved by De Witt that this fiſhery, ſince it fell into the hands of individuals, has ſeldom failed to be profitable; but while it was monopolized by the Dutch Greenland company, the profit was inconſiderable. Some idea may be formed of the extent to which the Dutch have carried this trade by ſtating that

219 Extent of their fiſhery.

Whale-Fiſhery.

that for a period of 46 years preceding the year 1722, 5886 ſhips were employed in it, and in this period they took 32,907 whales. Each whale, at an average, valued at 50l. makes the total amount above 16 millions ſterling.

The following table affords at one view a brief record of the Dutch whale-fiſhery from 1661 to 1788. The number of ſhips employed for each year, and the number of whales taken, are ſtated in ſeparate columns.

220 Ships employed, and produce of it, from 1661 to 1788.

A LIST *of the Number of Ships from* HOLLAND, *which were employed in the* GREENLAND *and* DAVIS STRAITS WHALE-FISHERY *ſince* 1661. N. B. *The* DUTCH *ſent Ships to* DAVIS STRAITS *for the firſt time in* 1719.

Years.	*Ships.*	*Fiſh.*	*Years.*	*Ships.*	*Fiſh.*
1661	133	452½	1708	122	533½
1662	149	862	1709	126	192¾
1663	202	932½	1710	137	62
1664	193	782	1711	117	631
1665	War with England, no Ships out.		1712	108	373¼
1666			1713	93	237½
1667			1714	108	1291
1668	155	573	1715	134	698½
1669	138	1013½	1716	153	535
1670	148	792	1717	179	392⅔
1671	158	1088½	1718	139	280¼
1672	War with England, no Ships out.		1719	211	346
1673			1720	228	$455\frac{17}{24}$
1674			1721	260	733⅔
1675	147	900½	1722	254	1101⅕
1676	145	182⅙	1723	233	314
1677	145	785⅓	1724	232	358
1678	120	1118¼	1725	226	530½
1679	126	792	1726	218	244
1680	151	1373	1727	202	402½
1681	175	876	1728	182	363½
1682	195	1444	1729	184	229⅓
1683	242	1338½	1730	186	248¾
1684	233	1153½	1731	164	298¼
1685	209	$1283\frac{7}{12}$	1732	176	314⅙
1686	189	664½	1733	184	360¼
1687	194	621½	1734	186	327
1688	214	340½	1735	185	496⅓
1689	160	241⅛	1736	191	857½
1690	117	785	1737	196	504½
1691	2	war with France.	1738	195	472
			1739	192	728¼
1692	32	56½	1740	187	665½
1693	90	175	1741	178	312¼
1694	63	$161\frac{5}{12}$	1742	173	358½
1695	97	187⅚	1743	185	937
1696	122	428	1744	187	1494
1697	131	1279	1745	184	568¾
1698	139	1483½	1746	180	1016
1699	151	775½	1747	164	776¼
1700	173	913⅚	1748	94	278⅙
1701	208	2071½	1749	157	619¼
1702	224	$687\frac{7}{12}$	1750	158	590½
1703	207	644	1751	162	$330\frac{5}{12}$
1704	130	652⅙	1752	159	546¼
1705	157	1678	1753	166	639⅝
1706	151	966½	1754	171	$672\frac{11}{12}$
1707	131	126	1755	181	720½
1756	186	568½	1773	134	444½
1757	180	423½	1774	130	450
1758	159	371½	1775	129	105
1759	155	464	1776	123	509
1760	154	454	1777	116	427¼
1761	161	357½	1778	111	306½
1762	165	189¾	1779	105	168¼
1763			1780	82	476
1764	161	224	1781	War with England, no ſhips out	
1765	165	477	1782		
1766	167	189⅓	1783	55	330
1767	165	179⅙	1784	62	198
1768	160	600⅓	1785	65	300
1769	152	1127	1786	67	476
1770	150	523	1787	67	239⅕
1771	150	143⅓	1788	69	190
1772	131	768½			

This table is intereſting, as it ſhews us the precarious nature of this fiſhery. But it would have been ſtill more valuable, if ſome other circumſtances had been ſtated, ſuch as the nature of the ſeaſons when the fiſhery was leſs ſucceſsful; whether the preceding winter was unuſually long or ſevere; whether the ſhort ſummer of theſe regions was not remarkable for extremes or ſudden changes of heat and cold, ſudden changes and variations of the wind, the prevalence of particular winds; or other facts which might enable us to trace the cauſes of the extrrordinary failure and ſucceſs of the fiſhery.

222 Attempt of the French to revive it.

The French made an attempt to revive this branch of trade in 1784. Six ſhips fitted out at Dunkirk at the expence of the late king, made ſome ſucceſsful voyages both in the northern and ſouthern whale-fiſhery. The advantages of the trade were obvious, and the French government were eager to improve them. In the year 1786, ſome of the inhabitants of the iſland of Nantucket, near Halifax in North America, were invited to ſettle at Dunkirk to carry on the fiſhery. Several families accepted the invitation, and to encourage them to proſecute the trade, they were permitted to enjoy peculiar privileges and immunities. Ships were ſent out to different ſeas, and had proſperous voyages. But this trade, as well as every other branch of French commerce, has probably been completely interrupted by the late revolution, and the particular circumſtances in which that nation has been with regard to foreign powers.

223 Other nations engage in it.

Beſides the nations which we have mentioned, who have been moſt deeply concerned in this fiſhery, the inhabitants of other countries have alſo embarked in it. Some ſhips were equipped at Embden in 1768 by order of the king of Pruſſia; the Swediſh government in 1774 granted to a company eſtabliſhed at Gottenburgh the excluſive privilege of the Davis ſtraits and Greenland fiſhery for 20 years; and Denmark in 1775 attempted to take a ſhare in the benefits of that fiſhery, which many of the nations of Europe, more enterpriſing or more induſtrious, had long ſucceſsfully enjoyed on the ſhores of the Daniſh dominions.

224 Time of the fiſhery.

The whale-fiſhery commences in May. It is about this time that the whales are ſeen in great numbers between the 76th and 79th degree of north latitude; and at a diſtance they exhibit the appearance of the ſmoke riſing from the chimnies of a great town by the water which is thrown into the air by their ſpouting or blowing. The fiſhery continues for the months of June and July, when it muſt be abandoned whether it has been ſucceſsful or unproſperous; becauſe it is neceſſary to be clear of the ice by the end of Auguſt. The ſhips return home at fartheſt in the month of September. But if the fiſhery happen to begin early in May, and prove abundant, they ſometimes return in June or July.

225
Mode of taking the whale by Europeans;

We ſhall now conclude this article with a ſhort account of the different modes that are practiſed in taking the whale. The following is employed in the Greenland fiſhery by Europeans. Every ſhip is provided with ſix boats, to each of which belong ſix men for rowing the boat, and a harpooner, whoſe buſineſs it is to ſtrike the whale with his harpoon. Two of theſe boats are kept conſtantly on the watch at ſome diſtance from the ſhip, faſtened to pieces of ice, and are relieved by others every four hours. As ſoon as a whale is perceived, both the boats ſet out in purſuit of it, and if either of them can come up before the whale finally deſcends, which is known by his throwing up his tail, the harpooner diſcharges his harpoon at him. There is no difficulty in chooſing the place where the whale is to be ſtruck, as ſome have aſſerted; for theſe animals only come up to the ſurface in order to breathe, or *blow*, as the fiſhermen term it, and therefore always keep the ſoft and vulnerable part of their bodies above water. A late improvement was made in the method of diſcharging the harpoon; namely, by ſhooting it out of a kind of ſwivel or muſquetoon: but it does not appear, that ſince this improvement was made the whale-fiſhing ſhips have had better ſucceſs than before. As ſoon as the whale is ſtruck, the men ſet up one of their oars in the middle of the boat as a ſignal to thoſe in the ſhip. On perceiving this, the watchman alarms all the reſt with the cry of *fall! fall!* upon which all the other boats are immediately ſent out to the aſſiſtance of the firſt.

The whale finding himſelf wounded, ſwims off with prodigious velocity. Sometimes he deſcends perpendicularly, and ſometimes goes off horizontally at a ſmall depth below the ſurface. The rope which is faſtened to the harpoon is about 200 fathoms long, and properly coiled up, that it may freely be given out as there is a demand for it. At firſt the velocity with which this line runs over the ſide of the boat is ſo great, that it is wetted to prevent its taking fire: but in a ſhort time the ſtrength of the whale begins to fail, and the fiſhermen, inſtead of letting out more rope, ſtrive as much as poſſible to pull back what is given out already, though they always find themſelves neceſſitated to yield at laſt to the efforts of the animal, to prevent his ſinking their boat. If he runs out the 200 fathoms of line contained in one boat, that belonging to another is immediately faſtened to the end of the firſt, and ſo on; and there have been inſtances where all the rope belonging to the ſix boats has been neceſſary, though half that quantity is ſeldom required. The whale cannot ſtay long below water, but again comes up to blow; and being now much fatigued and wounded, ſtays longer above water than uſual. This gives another boat time to come up with him, and he is again ſtruck with a harpoon. He again deſcends, but with leſs force than before; and when he comes up again, is generally incapable of deſcending, but ſuffers himſelf to be wounded and killed with long lances which the men are provided with for that purpoſe. He is known to be near death when he ſpouts up the water deeply tinged with blood.

The whale being dead, is laſhed alongſide the ſhip. They then lay it on one ſide, and put two ropes, one at the head, and the other in the place of the tail, which, together with the fins, is ſtruck off as ſoon as he is taken, to keep theſe extremities above water. On the off ſide of the whale are two boats, to receive the pieces of fat, utenſils, and men, that might otherwiſe fall into the water on that ſide. Theſe precautions being taken, three or four men with irons at their feet to prevent ſlipping, get on the whale, and begin to cut out pieces of about three feet thick and eight long, which are hauled up at the capſtan or windlaſs. When the fat is all got off, they cut off the whalebone of the upper jaw with an axe. Before they cut, they are all laſhed to keep them firm; which alſo facilitates the cutting, and prevents them from falling into the ſea; when on board, five or ſix of them are bundled together, and properly ſtowed; and after all is got off, the carcaſs is turned a-drift, and devoured by the white bears, who are very fond of it. In proportion as the large pieces of fat are cut off, the reſt of the crew are employed in ſlicing them ſmaller, and picking out all the lean. When this is prepared, they ſtow it under the deck, where it lies till the fat of all the whales taken during the fiſhery is on board; then cutting it ſtill ſmaller, they put it up in tubs in the hold, cramming them full and cloſe. At the end of the ſeaſon they return home, where the fat is boiled and preſſed to give out the oil.

226
By the people of Kamtſchatka.

But a different method is practiſed by the rude inhabitants of the different nations on the coaſts of the Frozen Ocean. On ſome parts of the ſea coaſts of Kamtſchatka, the return of the fiſhing ſeaſon is celebrated with a grand feſtival and great rejoicings in their ſubterraneous winter habitations, in which many ſuperſtitious ceremonies are performed. In one part of the ceremonies dogs are ſacrificed, with beating of drums and other rude muſical inſtruments. The prieſts who attend and conduct the feſtival, tranſport with great ſolemnity and pomp a figure of a whale, made of wood, from the ſummer habitation to the winter cottage.

227
Their previous ceremonies.

As the ceremonies proceed, the whole company aſſembled ſhout with a great noiſe, that the whale has made its eſcape from the cottage to the ſea; and they pretend even to ſhow the traces of the whale in its courſe, as if it had really made its way through the opening in the cottage. Theſe ceremonies being ended, the men prepare their nets, and embark in their canoes. The nets are ſet at the openings of bays, where fiſh, which are the food of the whale, are abundant, and in the purſuit of which entering the bays he is taken. When this is obſerved by the people in the canoes, they approach and ſecure their prize with ropes and ſtraps of leather. This event is again celebrated by their wives and children on ſhore with dancing, ſinging, and other demonſtrations of joy. But after the whale is ſufficiently ſecured, he is not brought on ſhore till another ceremony is performed. They put on their beſt clothes, and, with ſimilar ſolemnity, tranſport the image of the whale in wood from the winter to a new ſummer habitation. A lamp is there lighted up, and an attendant is appointed to watch and keep it burning from the ſpring to the autumn. The whale is then cut up, and furniſhes for a long time what is conſidered by the natives of thoſe regions a very delicate food.

228 By the people of the Kurile iſlands. Among the Kurile iſlands, which are ſituated near the ſouthern extremity of the peninſula of Kamtſchatka, the whales are moſt abundant about the beginning of autumn. At that time the inhabitants embark in their canoes, and ſearch for them in places where they generally find them aſleep on the ſurface of the water. When they are ſo fortunate as to find one in this ſituation, they approach with the leaſt poſſible noiſe; and, when they have come within the proper diſtance, they pierce him with poiſoned arrows. And although theſe wounds ſeem extremely ſlight, they are ſaid in a ſhort time to occaſion great pain. The whale thus wounded, moves about furiouſly, blows with great violence, and ſoon dies.

229 Of Iceland. We have already mentioned the mode of taking the whale which is practiſed by the Icelanders, in giving the natural hiſtory of the *balæna glacialis*, or Iceland whale. It is, according to Anderſon, by throwing blood into the ſea, when they get between the whale and the ſhore. They then endeavour to drive him towards the ſhore; but the whale finding himſelf purſued, attempts to regain the ocean, and approaching the blood, is alarmed; and rather than ſwim acroſs it, returns towards the land, where he is often thrown on ſhore. But this is contradicted by Horrebow, who ſays, that the uſual method of killing the whale in Iceland, is with the harpoon.

230 Of Greenland. When the whale returns to the coaſts of Greenland, the fiſhermen put on their large ſkin coats, and furniſh themſelves with a large knife, and a ſtone to ſharpen it. They provide alſo harpoons, ſpears, and arrows, with a number of large ſkins of the ſea-dog inflated. Thus equipped, they launch their canoes, and embark with their wives and children. The harpoon which they generally employ, is pointed with bone, or a ſharp ſtone. Some indeed have harpoons of iron, which they procure from the Danes by barter for the oil or fat of the whale. The ſcarcity of wood and iron makes theſe articles extremely valuable to Greenlanders, and has excited their ingenuity to avoid the riſk of loſing them. For this purpoſe an inflated bladder of the ſkin of the ſea-dog is attached to the harpoon, ſo that in caſe it ſhould not reach the whale when they attempt to ſtrike, it may float on the water, and be recovered. Thus equipped, they launch out into the ocean in their ſmall canoes, and, with great intrepidity, attack the largeſt whales. They approach them, ſays Anderſon, with aſtoniſhing boldneſs, and endeavour to fix, by means of their harpoon, which they throw at his body, ſome of the ſkins inflated with air. For, notwithſtanding the enormous bulk of this animal, two or three of theſe ſkins, by the reſiſtance which they make to the water, on account of their diminiſhed ſpecific gravity, greatly impede his attempts at plunging into the deeep. Having by this means ſucceeded in arreſting his progreſs, they approach nearer; and, with their lances, pierce his body, till he become languid and feeble with the loſs of blood, and at laſt dies. The fiſhermen then plunge into the ſea with their ſkin-jackets filled with air, and ſwim to their prize: and, floating on the ſurface of the water, they cut off with their knives from every part of the whale the fat or blubber, which is thrown into the canoes. And, notwithſtanding the rudeneſs and imperfection of their inſtruments, their dexterity is ſuch, that they can extract from the mouth the greateſt, or at leaſt the beſt part of the whalebone.

231 Aſtoniſhing mode by the Floridan Indians. But the mode of fiſhing the whale, the boldeſt and moſt aſtoniſhing, is that which is practiſed by the Indians on the coaſt of Florida. When a whale appears, they faſten to their bodies two pieces of wood and a mallet; and theſe inſtruments, with their canoe, conſtitute the whole of their fiſhing equipage. When they approach the whale, they throw themſelves into the water, ſwim directly towards him, and have the addreſs to get upon his neck, taking care to avoid the ſtroke of his fins or tail. When the whale firſt ſpouts, the Indian introduces one of the pieces of wood into the opening of one of the blow-holes, and drives it home with the mallet. The whale thus attacked, inſtantly plunges, and carries the Indian along with him, who keeps faſt hold of the animal. The whale, which has now only one blow-hole, ſoon returns to the ſurface of the water to reſpire; and, if the Indian ſucceeds in fixing the other piece of wood into the ſecond blow-hole, the whale again deſcends to the bottom, but a moment after re-appears on the ſurface, where he remains motionleſs, and immediately expires by the interruption of the function of reſpiration.

EXPLANATION OF PLATES.

232 Plates explained. Plate CXL.—Fig. 1. The large whalebone or Greenland whale, is from 40 to 60 feet long, and more than one half the length in circumference at the thickeſt part. This whale is taken on account of the oil and the whalebone.

Fig. 2. The narhwal or unicorn-fiſh, yields a ſmall quantity of oil, but it is ſaid to be of a ſuperior quality. The horns or teeth are much valued, and are in ſome reſpects preferable to ivory. They are from 9 to 10 feet long. The fleſh is greatly eſteemed by the inhabitants of Greenland.

Fig. 3. The large ſpermaceti whale, which is taken on account of the oil, and alſo on account of the more valuable ſubſtance, ſpermaceti, which is found chiefly in cells within the ſkull. The figure here given is taken from one of the 31 which came on ſhore in 1784, near Audierne in France. The length was 44 feet.

Fig. 4. The grampus. This figure was taken from one caught at the mouth of the Thames in 1759. It was 24 feet long.

Plate CXLI.—Fig. 1. and 2. exhibits a view of the courſe of the blow-hole in the cetaceous fiſhes.

Fig. 1. ſhews the blow-hole of the whalebone and ſpermaceti whale. In the whalebone whale it is double; and the courſe of it is marked by the dotted line ABCD It is ſingle in the ſpermaceti whale, and marked by the dotted lines AEFD.

Fig. 2. ſhews that of the monodon and delphinus. That of the monodon, which is ſingle, is ſhewn by the dotted line ABCD, terminating at the back part of the

Fig. 1. Balæna Mysticetus, Large Whale-bone Whale.

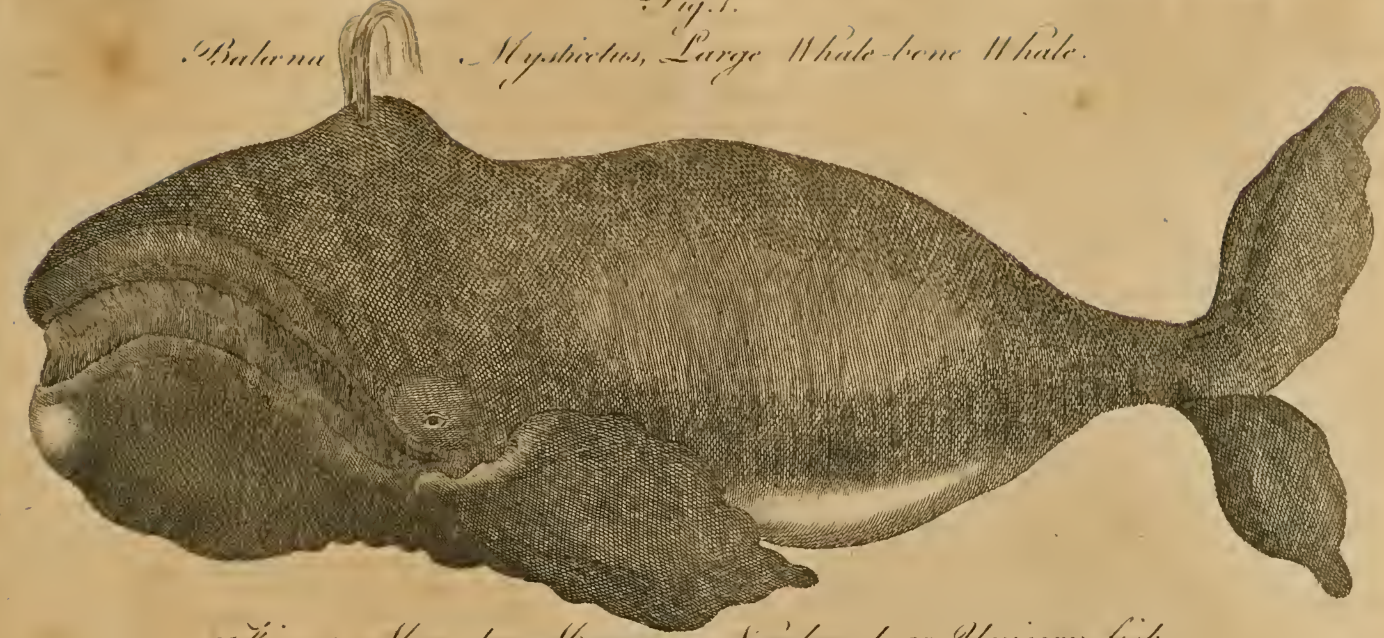


Fig. 2. Monodon Monoceros, Narhwal, or Unicorn fish.

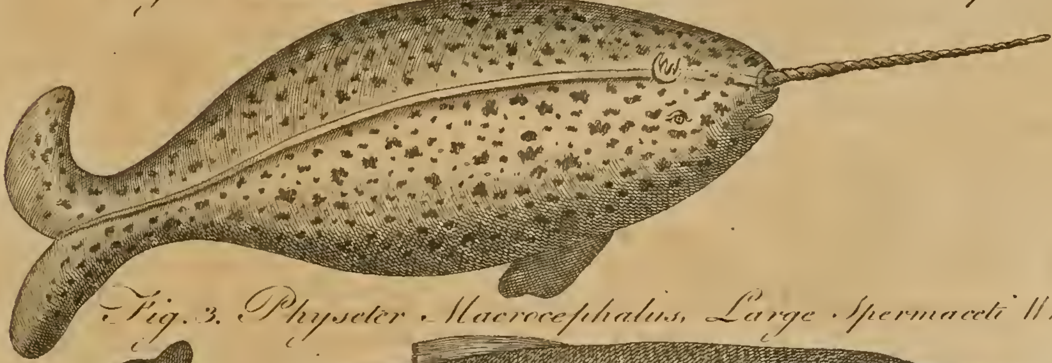


Fig. 3. Physeter Macrocephalus, Large Spermaceti Whale.

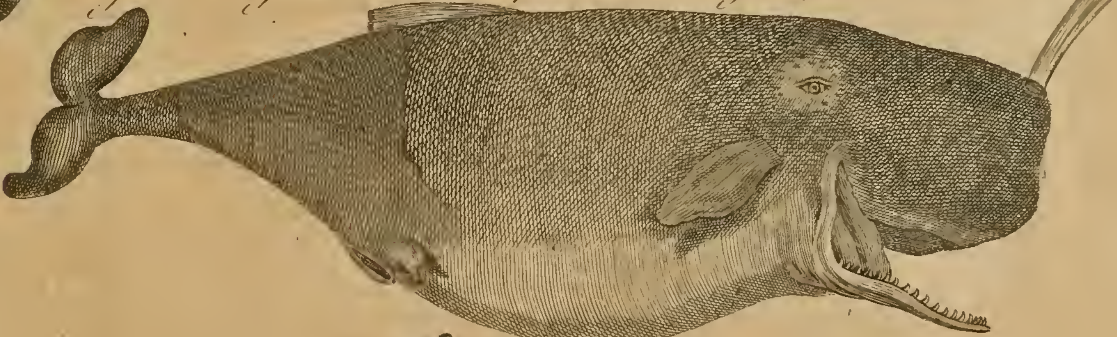
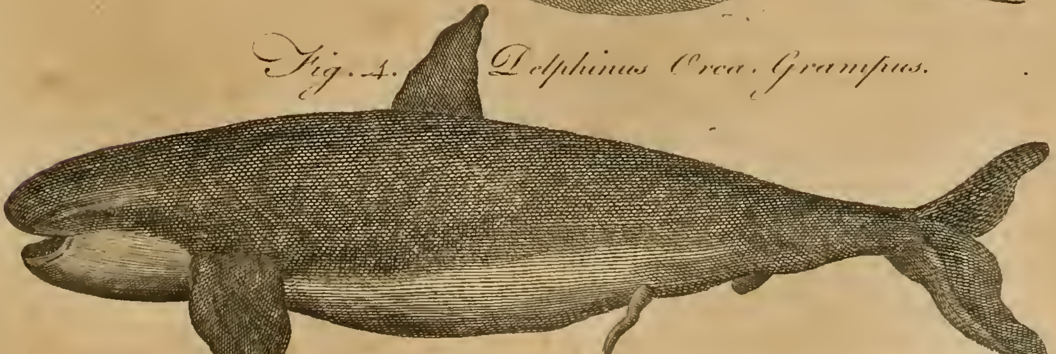


Fig. 4. Delphinus Orca, Grampus.



A. Bell Prin. Wal. Sculptor fecit

CETOLOGY.

Plate CXLI.

Fig. 1.

Blowhole of the Whalebone and Spermaceti Whale.

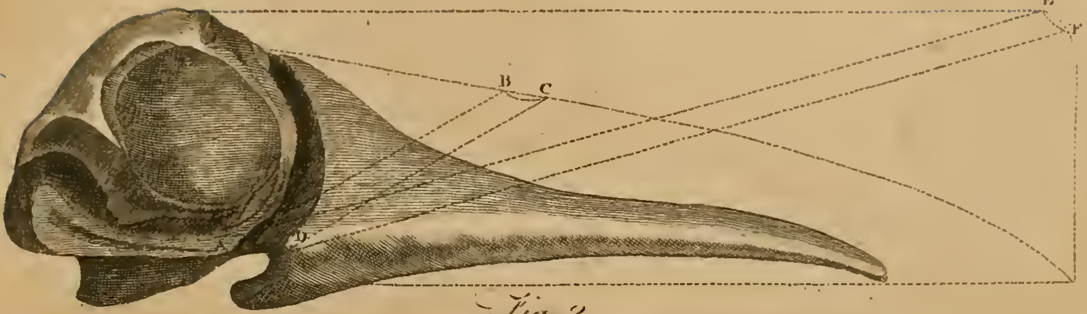


Fig. 2.

Blowhole of the Unicorn fish and Dolphin.

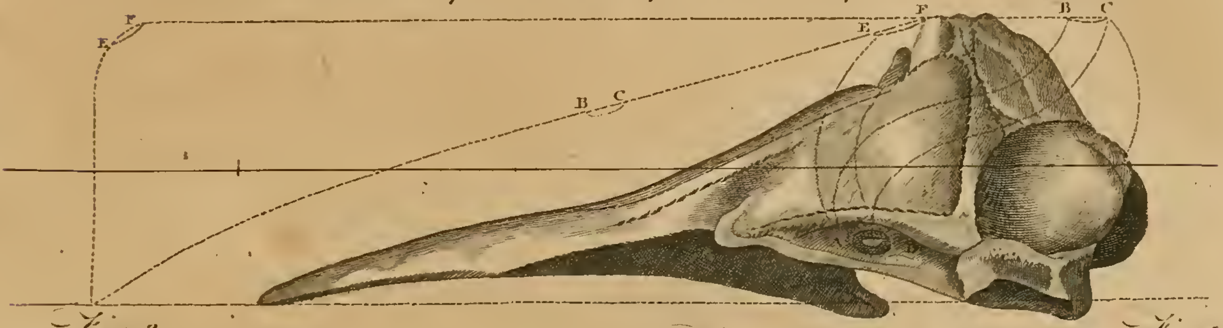


Fig. 3.

Perpendicular View. of the Whalebone.

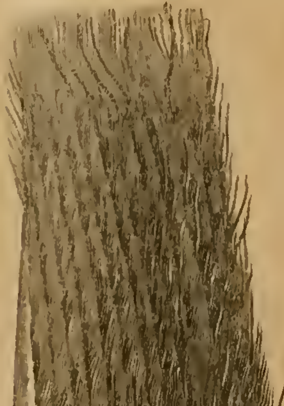


Fig. 4.

Lateral View.

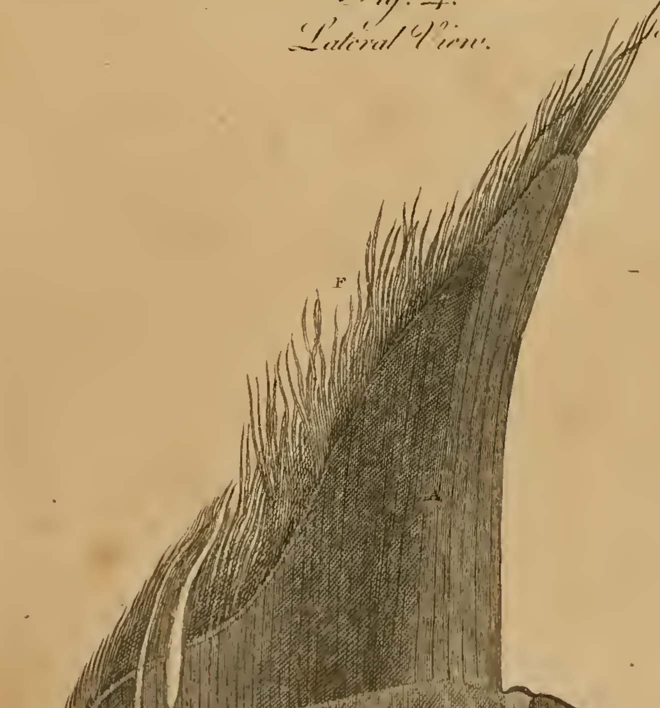
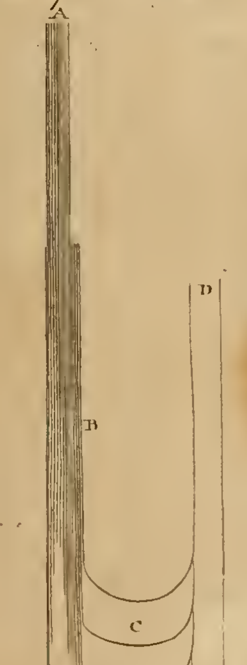


Fig. 5.

Growth of the Whalebone.



A. Bell Prin. Wal.s Sculptor fecit.

the head; and that of the claſs delphinus by the dotted line AEFD, terminating at the top of the head.

Fig. 3. A perpendicular ſection of ſeveral plates of whalebone in their natural ſituation in the gum. The inner edges or ſhorteſt terminations are removed, and the cut edges ſeen from the inſide of the ſnout. A, the upper part, ſhews the diſtance of the plates from each other. C, the lower part, ſhews the white ſubſtance on which they grow, and the baſis on which they ſtand.

Fig. 4. A ſide view of one of the plates of whalebone. A, the part which projects beyond the gum. B, the portion which is ſunk in the gum. CC, a white ſubſtance which ſurrounds the whalebone, forming there a projecting bead, and alſo paſſing between the plates to form their external lamellæ. DD, the part analogous to the gum. E, a fleſhy ſubſtance covering the jaw-bone, on which the inner lamella of the plate is formed. F, the termination of the whalebone in the hair.

Fig. 5. An outline to ſhew the mode of growth of the plates, and of the white intermediate ſubſtance. A, the middle layer of the plate, which is formed upon a pulp or cone that paſſes up in the centre of the plate. The termination of this layer forms the hair. B, one of the outer layers, which is formed from the intermediate white ſubſtance. CCCC, the intermediate white ſubſtance, the laminæ of which are continued along the middle layer, and form the ſubſtance of the plate of whalebone. D, the outline of another plate of whalebone. E, the baſis on which the plates are formed, which adheres to the jaw-bone.

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Cette || Ceuta.

CETTE, a maritime town of France, in Languedoc, ſeated at the place where the canal of Languedoc begins, between Montpellier and Agde, on the bay of Magueiona, in the Mediterranean ſea. E. Long. 3. 15. N. Lat. 43. 25.

CETUS, in *Aſtronomy*, the whale; a large conſtellation of the ſouthern hemiſphere, under Piſces, and next the water of Aquarius. The ſtars in the conſtellation Cetus, in Ptolemy's catalogue, are twenty-two; in Tycho's twenty-one; in Hevelius's forty-five; in the Britannic catalogue ninety-ſeven.

Cetus is repreſented by the poets as the ſea-monſter which Neptune, at the ſuit of the nymphs, ſent to devour Andromeda for the pride of her mother, and which was killed by Perſeus. In the mandible of Cetus is a variable ſtar which appears and diſappears periodically, paſſing through the ſeveral degrees of magnitude both increaſing and diminiſhing, in about 333 days. See ASTRONOMY.

CEVA, a ſtrong town of Piedmont in Italy, ſeated on the river Tanero, with a ſtrong fort, in E. Long. 8. 8. N. Lat. 44. 20.

CEVENNES, mountains of Languedoc in France, remarkable for the frequent meetings of the Proteſtants there as a place of ſecurity againſt the tyranny of their governors. In Queen Anne's reign there was an attempt made to aſſiſt them by an Engliſh fleet in the Mediterranean; but to no purpoſe, for the French had occupied the paſſages.

CEUTA, a maritime town of Barbary in Africa, and in the kingdom of Fez, ſeated on the ſtraits of Gibraltar, oppoſite that place, in W. Long. 6. 25. N. Lat. 36. 35. John king of Portugal took it from the Moors in 1415, but it now belongs to Spain. In 1697, it ſuſtained a vigorous ſiege by the Moors.

Ceylon.

CEYLON, a large iſland in the Eaſt Indies, which lies between 5° 40′ and 10° 30′ north latitude; and between 79° and 82° eaſt longitude. It is ſituated at the entrance of the bay of Bengal, by which it is bounded on the north. On the north-weſt it is ſeparated from the Coromandel coaſt by the gulf of Manaar, a narrow ſtrait full of ſhoals, and impaſſable by large ſhips; and is diſtant about 60 leagues from Cape Comorin, the ſouthern point of the peninſula of India. Its circumference is computed to be about 900 miles; and its length from Point Pedro at the northern extremity to Donderhead at the ſouthern is about 300 miles. Its breadth is very unequal, being in ſome parts only from 40 to 50 miles, while in others it extends to 60, 70, and even 100.

The appearance of the eaſtern coaſt is bold and rocky, and a few reefs of rocks run out into the ſea on the ſouth-eaſt between Point de Galle and Batacolo. The deep water on the eaſtern ſhores admits the approach of the largeſt veſſels in ſafety; and if that ſide of the iſland be the leaſt fertile, its other defects are amply compenſated by the harbours of Trincomalee and Batocolo. The north and north-weſt coaſt from Point Pedro to Columbo is flat, and everywhere indented with inlets of the ſea. The largeſt of them extends almoſt quite acroſs the iſland from Mullipatti to Jafnapatam on the north-weſt point of the iſland; and forms the peninſula of Jafnapatam. Several of theſe inlets form ſmall harbours.

The interior of the iſland abounds with ſteep and lofty mountains, covered with thick foreſts, and full of almoſt impenetrable jungles. The woods and mountains completely ſurround the dominions of the king of Candy, and ſeem deſtined by nature to defend him againſt thoſe foreign enemies, whoſe ſuperior ſkill and power have deprived him of the open tracts on the ſea-coaſt. The moſt lofty range of mountains divides the iſland nearly into two parts, and ſo completely ſeparates them from each other, that both the climate and ſeaſons on either ſide are eſſentially different. Theſe mountains alſo obſtruct completely the effect of the monſoons, which ſet in periodically from oppoſite ſides of them; ſo that not only the oppoſite ſea-coaſt, but the whole country in the interior, ſuffers very little from theſe ſtorms.

The monſoons in Ceylon are connected with thoſe on the Coromandel and Malabar coaſts; but they ſet in much ſooner on the weſtern than the eaſtern ſide of the iſland. On the weſt ſide, where Columbo lies, the rains prevail in the months of May, June, and July, the ſeaſon when they are felt on the Malabar coaſt. This monſoon is uſually extremely violent, being accompanied with dreadful ſtorms of thunder and lightning, together with vaſt torrents of rain, and violent ſouth-weſt winds. During its continuance, the northern parts of the iſland are very little affected, and are even generally dry. In the months of October and November, when the oppoſite monſoon ſets in on the Coromandel coaſt, it is the north of Ceylon which is affected, and ſcarcely any impreſſion of it is felt in the ſouthern parts.

Theſe monſoons paſs ſlightly over the interior, and ſeldom occaſion any conſiderable inconvenience. But this part of the iſland is not altogether freed from the dreadful ſtorms which ſo terribly ravage the tropical climates. During its own periodical ſeaſon, which happens in March and April, the rain pours down in torrents, and the thunder and lightning are terrible.

From the ſituation of this iſland, ſo near the equator, the days and nights are nearly of equal length; the variation during the two ſeaſons not exceeding 15 minutes. The ſeaſons are more regulated by the monſoons than the courſe of the ſun; for although the iſland lies to the north of the line, the cooleſt ſeaſon is during the ſummer ſolſtice, while the weſtern monſoon prevails. Their ſpring commences in October; and the hotteſt ſeaſon is from January to the beginning of April. The heat, during the day, is nearly the ſame throughout the whole year; the rainy ſeaſon, however, renders the nights much cooler, from the dampneſs of the earth, and the prevalence of winds during the monſoons. The climate, upon the whole, is much more temperate than on the continent of India. This temperate climate, however, is chiefly confined to the coaſt where the ſea-breezes have room to circulate. In the interior of the country, owing to the thick and cloſe woods, and the hills which crowd upon each other, the heat is many degrees greater than on the ſea-coaſt, and the climate often extremely ſultry and unhealthy.

The principal harbours in the iſland for large ſhips, are Trincomalee and Point de Galle; they alſo come to anchor, and at certain ſeaſons of the year moor ſecurely, in the roads of Columbo. There are ſeveral other inferior ports round the iſland, which afford ſhelter to the ſmaller coaſting veſſels.

The two principal rivers are the Malivagonga and the Mulivaddy. The former takes its riſe among the hills to the ſouth-eaſt of Candy, and nearly ſurrounds that city. After a variety of circuitous windings among the mountains, it at laſt diſcharges itſelf into the ſea at Trincomalee. This river is ſo deep as to be fordable only towards the ſource; but the rocks, which everywhere break its courſe, prevent it from being navigated. The Mulivaddy riſes from the foot of a very high mountain, known to Europeans by the name of Adam's Peak, and ſituated about ſixty miles to the north-eaſt of Columbo. This river falls into the ſea by ſeveral branches: the largeſt of theſe empties itſelf about three miles from the fort of Columbo, after having nearly ſurrounded a large tract of the level country, of which it forms a peninſula.

Beſides the rivers with which Ceylon abounds, there are many lakes and canals communicating with them, particularly in the neighbourhood of Columbo and Nigumbo. They are often of conſiderable extent, and of great utility to the inhabitants in their neighbourhood, who have thus an opportunity of readily tranſporting their ſeveral articles of trade; and it is by this means alſo that the towns on the coaſt are ſupplied with the greateſt abundance of freſh water fiſh.

The internal communications by land through the iſland have ſcarcely paſſed the firſt ſtage of improvement. Along the ſea-coaſts indeed there are roads and ſtations for travellers; but theſe roads are in many places rugged and ſteep.

The ſoil in general is ſandy, with a ſmall mixture of clay. In the ſouth-weſt parts, particularly about Columbo, there is a great deal of marſhy ground very rich and productive. This tract, however, is chiefly occupied with cinnamon plantations, and the reſt of the iſland, in its preſent ſtate of cultivation, does not produce a ſufficient quantity of rice for the conſumption of its inhabitants.

Ceylon was originally divided into a number of diſtinct petty kingdoms, ſeparated by the ſeveral rivers and mountains which are diſperſed over the face of the iſland, and ſubject each to its own independent ſovereign. In proceſs of time, however, the whole country was reduced under the dominion of the king of Candy, and divided by him into a few great provinces, from which ſeveral of the numerous titles he ſtill retains were derived. Theſe provinces were Candy, Coitu, Matura, Dambadar, and Sittivacca, which included the rich diſtricts on the weſt coaſt. The chief of theſe provinces was Candy, ſituated in the centre of the iſland, and honoured with the royal reſidence. The king holds his court there to this day; and though all the other provinces have been more or leſs encroached upon, no part of Candy has ever been reduced to permanent ſubjection under a foreign power. The great diviſions of the iſland now are reduced to two; the one comprehending thoſe parts under the dominion of Europeans, and the other thoſe which ſtill remain to the natives.

Little was known of the iſland of Ceylon previous to the arrival of the Portugueſe in 1505, who were admitted by the king of the country in a friendly manner, and received from him an annual tribute for their protection againſt external invaſion, particularly againſt the attacks of the Arabs, who had long haraſſed and oppreſſed the Ceyloneſe. The inhabitants at that time, as at preſent, conſiſted of two diſtinct races, the Bedahs, who lived in the foreſts, particularly in the northern parts, and the Cingleſe, who inhabited the ſea-coaſt. Columbo, now the European capital at Ceylon, was at that time the royal reſidence. Cinnamon was even then the chief product and ſtaple commodity of the country. Two hundred and fifty thouſand pounds weight were annually delivered by the king to the Portugueſe in name of tribute. The inhabitants ſuffered great cruelties and oppreſſion under the Portugueſe, and were glad of an opportunity of throwing off the yoke and putting themſelves under the protection of the Dutch. In 1632, a ſtrong armament was ſent out by the latter to act in concert with the native prince; and, after a bloody ſtruggle, the Portugueſe were at laſt expelled from the iſland. Columbo ſurrendered to the Dutch arms in 1656, and this terminated the dominion of the Portugueſe in the iſland. In the year 1795, a body of Britiſh troops was ſent for the conqueſt of Ceylon, and after various military operations, this valuable poſſeſſion was added to the Britiſh colonies.

The chief towns in Ceylon are Trincomalee and Columbo. Trincomalee lies in latitude 8° 30′. It runs in a north-eaſt direction along one branch of the bay. The country around it is mountainous and woody; the ſoil uncultivated and rather barren, and the whole appearance wild.

Trincomalee, from its ſituation and conſtruction, is naturally ſtrong. It occupies more ground than Columbo, but contains a much ſmaller number of houſes, and thoſe inferior in ſize and appearance to thoſe which are to be met with in ſeveral towns on the ſouth-weſt coaſt. The circumference of Trincomalee, within the walls, is about three miles: within this ſpace is alſo included a hill or riſing point, immediately over the ſea, and covered with bruſhwood,

The fort is ſtrong, and commands the principal bays; and, in particular, the entrance into the grand harbour, or inner bay, which affords at all ſeaſons, and in every variety of weather, a ſecure ſhelter to ſhips of all deſcriptions, being land-locked on all ſides, and ſufficiently deep and capacious to receive any number of the largeſt veſſels.

This harbour, from its nature and ſituation, is that which ſtamps Ceylon one of our moſt valuable acquiſitions in the Eaſt Indies. As ſoon as the violent monſoons commence, every veſſel which is caught by them in any other part of the bay of Bengal, is obliged immediately to put to ſea to prevent inevitable deſtruction. At theſe ſeaſons Trincomalee and Bombay alone, of all the ports on the different coaſts of the peninſula of India, are capable of affording a ſafe retreat. The incalculable advantages to be derived from ſuch a harbour, are increaſed by its proximity and eaſy acceſs to our ſettlements in the bay of Bengal.

Columbo is the capital of Ceylon and the ſeat of government. Although Trincomalee, on account of its ſituation and harbour, be of more conſequence to this nation to retain, yet Columbo in every other reſpect is greatly ſuperior. The number of its inhabitants is much greater; its fort and black town are much larger; the country where it is ſituated is far more fertile, and the rich diſtrict depending upon it much wider, being not leſs than 20 leagues in length, and 10 in breadth. It is ſituated in the weſt, or rather towards the ſouth-weſt part of the iſland, in about 7° north latitude and 78° eaſt longitude from London.

The plan of Columbo is regular. It is nearly divided into four equal quarters by two principal ſtreets, which croſs each other, and extend the whole length of the town. To theſe, ſmaller ones run parallel, with connecting lanes between them. At the foot of the ramparts on the inſide is a broad ſtreet or way, which goes round the whole fort, and communicates with the baſtions and ſoldiers barracks; and alſo affords, at the different angles, open ſpaces for their private parading.

Beſide the European inhabitants of Ceylon, the natives are quite diſtinct from each other in manners and civilization. The Cingleſe, who inhabit the low lands and parts contiguous to the coaſts, live entirely under the dominion of whatever European nation has been able to acquire poſſeſſion of that part of the iſland. The nature of the country they inhabit indeed leaves them hardly any alternative but unconditional ſubmiſſion, unleſs they could either meet the Europeans in open battle, or conſent to quit their plentiful fields for the barren mountains of the interior.

They are a quiet, inoffenſive people; exceedingly grave, temperate, and frugal. Their bodies partake of the indolence of their minds, and it is with reluctance they are rouſed to any active exertion. When, however, they are obliged to apply themſelves to any work, ſuch as agriculture, they are capable of undergoing a great deal of labour.

The milder virtues form the moſt prominent features of the Cingleſe character. They are gentle, charitable, and friendly, and have ſcarcely any of the falſe, treacherous, and deſigning arts which are often found among the Candians. With much leſs ſmoothneſs and courteouſneſs of face and manner than the latter, they have much ſincerer hearts. On examining the countenances and carriage of theſe two claſſes of Ceyloneſe, it is eaſy to perceive the difference ariſing from the reſpective circumſtances in which they are placed. The countenance of the Candian is erect, his look haughty, his mien lofty, and his whole carriage marked by the pride of independence.

The looks of the Cingleſe even denote a degree of effeminacy and cowardice, which excites the contempt of the Candians; although the latter, with all their boaſted ſpirit, can never venture to attack an European but by the ſame method as the Cingleſe, and are equally cautious in waiting the convenient moment of aſſaulting him from the buſhes, in which they have concealed themſelves.

The moſt ſingular part of the inhabitants of Ceylon are the Bedahs or Vaddahs. The origin of the Bedahs or Vaddahs, who inhabit the deepeſt receſſes of the Ceyloneſe foreſts, has never been traced, as no other race can be found in the eaſtern world which correſponds with them. Conjecture has, indeed, been buſy on the occaſion, as it uſually is where real information is wanting. The Bedahs are generally ſuppoſed to have been the aboriginal inhabitants of the iſland, who, upon being overwhelmed by their Cingleſe invaders, preferred the independence of ſavages to a tame ſubmiſſion. A current tradition, however,

ever, aſſigns them a different origin. It is related that they were caſt away on the iſland, and choſe to ſettle there; but refuſing, upon a certain occaſion, to aſſiſt the king in his wars againſt ſome foreign enemies, they were driven out from the ſociety of the natives, and forced to take up their abode in the moſt unfrequented foreſts. Some imagine that the Bedahs are merely a part of the native Candians, who choſe to retain their ancient ſavage freedom, when their brethren of the plains and valleys ſubmitted to the cultivation of the earth, and the reſtraints of ſociety. This opinion reſts entirely on thoſe Bedahs, who are moſt known, ſpeaking a broken dialect of the Cingleſe. It is, however, by no means aſcertained that this is the univerſal language of the Bedahs; nor is any account of their origin ſupported by the ſlighteſt ſhadow of proof.

Among the animals of Ceylon, and at the head of the claſs of quadrupeds, is the elephant, which is conſidered as ſuperior to thoſe found in any other part of the world. The oxen are of very ſmall ſize, ſcarcely exceeding that of calves of a year old. They are of that ſpecies which have the hump on the ſhoulder; but are inferior in quality, as well as in ſize, to any found on the Indian continent. The beef is ſometimes of a good quality, and forms the chief food of the European ſoldiers. Buffaloes are found in great numbers in the iſland, both in a wild and tame ſtate. They are wild and untractable; and even when tamed and trained to the draught, for which, being ſtronger and larger than the oxen, they are well adapted, they retain a good deal of their original manners. A variety of deer and elks are found in Ceylon; eſpecially the gazelle, a very ſmall ſpecies, about the ſize of our hare, which is caught by the natives and brought to market in cages, where they are ſold for about 1 s. a piece. Hares, ſimilar to the European, abound in every part of the iſland; a ſmall ſpecies of tyger, the tyger cat, the leopard, the jackal, porcupines, racoons, ſquirrels, and ſometimes, but rarely, the hyena and the bear, are found in Ceylon. Birds, inſects, ſerpents, and other reptiles, ſuch as are uſually to be met with in the larger iſlands of the Indian ocean, or on the neighbouring continent, are common on this iſland.

Ceylon abounds in all the vegetables and fruits which are found within the tropical regions. But among the vegetable productions of Ceylon, the moſt valuable, and what may be reckoned the ſtaple commodity of the iſland, is the cinnamon.

The principal woods, or gardens, as they are called, where the cinnamon is procured, lie in the neighbourhood of Columbo. The grand garden near the town is ſo extenſive as to occupy a tract of country from 10 to 15 miles in length, and ſtretching along from the north-eaſt to the ſouth of the diſtrict. Nature has here concentrated both the beauty and the riches of the iſland. Nothing can be more delightful to the eye than the proſpect which ſtretches around Columbo. The low cinnamon trees which cover the plain allow the view to reach the groves of evergreens, interſperſed with tall clumps, and bounded everywhere with extenſive ranges of cocoa-nut and other large trees. The whole is diverſified with ſmall lakes and green marſhes, ſkirted all around with rice and paſture fields. In one part the intertwining cinnamon trees appear completely to clothe the face of the plain; in another, the openings made by the interſecting footpaths juſt ſerve to ſhew that the thick underwood has been penetrated.

The ſoil beſt adapted for the growth of the cinnamon is a looſe white ſand. Such is the ſoil of the cinnamon gardens around Columbo, as well as in many parts around Nigumbo and Caltura, where this ſpice is found of the ſame ſuperior quality. Of late years little is procured from the interior; and what is brought thence is coarſer and thicker in the appearance, and of a hot pungent taſte.

As this ſpice conſtitutes the wealth of Ceylon, great pains are taken to aſcertain its quality, and to propagate the choiceſt kinds. The prime ſort, and that which grows in the gardens around Columbo, is procured from the *laurus cinnamomum.* This is a tree of a ſmall ſize, from four to ten feet in height: the trunk is ſlender, and like ſeveral of our ſhrubs, a number of branches and twigs ſhoot out from it on every ſide. The wood is ſoft, light, and porous, in appearance much reſembling that of our oſier; and when barked it is chiefly fit for fuel, to which uſe it is commonly converted. It is, however, ſometimes ſawed into planks, and manufactured into caddies and other pieces of furniture; but its ſcent does not ſecure it from the attacks of the worms.

The cinnamon tree produces a ſpecies of fruit reſembling an acorn, but not ſo large, which ripens about the latter end of autumn, and is gathered by the natives for the purpoſe of extracting the oil. The proceſs they employ is to bruiſe the fruit, boil it, and ſkim off the oil: this they uſe for their hair and body on great occaſions, and alſo for burning in their lamps. When mixed with cocoa-nut oil, it gives extremely good light. The kings of Candy uſe it for this purpoſe, and formerly commanded their ſubjects to bring them a certain quantity as a yearly tribute. When any ambaſſadors are ſent to theſe princes, they always burn this oil during the time of audience.

The pearl-fiſhery in the bay of Condatchy, during the ſeaſon, exhibits one of the moſt intereſting ſcenes in Ceylon. The banks, where it is carried on, extend ſeveral miles along the coaſt from Manaar ſouthward, off Arippo, Condatchy, and Pomparipo. The principal bank is oppoſite to Condatchy, and lies out at ſea about 20 miles. The firſt ſtep, previous to the commencement of the fiſhery, is to have the different oyſter banks ſurveyed, the ſtate of the oyſters aſcertained, and a report made on the ſubject to government. If it has been found that the quantity is ſufficient, and that they are arrived at a proper degree of maturity, the particular banks to be fiſhed that year are put up for ſale to the higheſt bidder, and are uſually purchaſed by a black merchant. Government ſometimes judges it more advantageous to fiſh the banks on its own account, and to diſpoſe of the pearls afterwards to the merchants. When this plan is adopted, boats are hired for the ſeaſon on account of government, from different quarters; the price varies conſiderably, according to circumſtances; but is uſually from 500 to 800 pagodas for each boat.

As neither the ſeaſon, nor the convenience of the perſons attending, would permit the whole of the banks to be fiſhed in one year, they are divided into three or four different portions, which are fiſhed one portion annually in ſucceſſion. The different portions are completely diſtinct, and are ſet up ſeparately to ſale, each in the year in which it is to be fiſhed. By this means a ſufficient interval is given to the oyſters to attain their proper growth; and as the portion firſt uſed has generally recovered its maturity by the time the laſt portion has been fiſhed, the fiſhery becomes almoſt regularly annual, and may thus be conſidered as yielding a yearly revenue. The oyſters are ſuppoſed to attain their completeſt ſtate of maturity in ſeven years; for, if left too long, it is ſaid that the pearl becomes ſo large and inconvenient to the fiſh, that it throws it out of the ſhell.

The fiſhing ſeaſon commences in February, and ends about the beginning of April. The period allowed to the merchant to fiſh the banks is ſix weeks, or two months at the utmoſt; but there are ſeveral interruptions, which prevent the fiſhing days from exceeding more than about thirty. If it happens to be a very bad ſeaſon, and many ſtormy days intervene during the period allotted, the purchaſer of the fiſhery is often allowed a few days more as a favour.

During the ſeaſon, all the boats regularly ſail and return together. A ſignal gun is fired at Arippo, about ten o'clock at night, when the whole fleet ſets ſail with the land breeze. They reach the banks before daybreak; and at ſunriſe commence fiſhing. In this they continue buſily occupied till the ſea breeze, which ariſes about noon, warns them to return to the bay. As ſoon as they appear within ſight, another gun is fired, and the colours hoiſted, to inform the anxious owners of their return. When the boats come to land, their cargoes are immediately taken out, as it is neceſſary to have them completely unloaded before night. Whatever may have been the ſucceſs of their boats, the owners ſeldom wear the looks of diſappointment; for, although they may have been unſucceſsful one day, they look with the moſt complete aſſurance of better fortune to the next; as the Brahmins and conjurers, whom they implicitly truſt in defiance of all experience, underſtand too well the liberality of a man in hopes of good fortune, not to promiſe them all they can deſire.

Each of the boats carries 20 men, with a *tindal* or chief boatman, who acts as pilot. Ten of the men row and aſſiſt the divers in re-aſcending. The other ten are divers; they go down into the ſea by five at a time; when the firſt five come up the other five go down, and by this method of alternately diving, they give each other time to recruit themſelves for a freſh plunge.

In order to accelerate the deſcent of the divers, large ſtones are employed: five of theſe are brought in each boat for the purpoſe; they are of a reddiſh granite, common in this country, and of a pyramidal ſhape, round at top and bottom, with a hole perforated through the ſmaller end ſufficient to admit a rope. Some of the divers uſe a ſtone ſhaped like a half-moon, which they faſten round the belly when they mean to deſcend, and thus keep their feet free.

Theſe people are accuſtomed to dive from their very infancy, and fearleſsly deſcend to the bottom in from four to ten fathom water, in ſearch of the oyſters. The diver, when he is about to plunge, ſeizes the rope, to which one of the ſtones we have deſcribed is attached, with the toes of his right foot, while he takes hold of a bag of net work with thoſe of his left; it being cuſtomary among all the Indians to uſe their toes in working or holding as well as their fingers, and ſuch is the power of habit that they can pick up even the ſmalleſt thing from the ground with their toes as nimbly as an European could do with his fingers. The diver thus prepared, ſeizes another rope with his right hand, and holding his noſtrils ſhut with the left, plunges into the water, and by the aſſiſtance of the ſtone ſpeedily reaches the bottom. He then hangs the net round his neck, and with much dexterity, and all poſſible diſpatch, collects as many oyſters as he can while he is able to remain under water, which is uſually about two minutes. He then reſumes his former poſition, makes a ſignal to thoſe above by pulling the rope in his right hand, and is immediately by this means drawn up and brought into the boat, leaving the ſtone to be pulled up afterwards by the rope attached to it.

The exertion undergone during this proceſs is ſo violent, that upon being brought into the boat, the divers diſcharge water from their mouth, ears, and noſtrils, and frequently even blood. But this does not hinder them from going down again in their turn. They will often make from 40 to 50 plunges in one day; and at each plunge bring up about 100 oyſters. Some rub their bodies over with oil, and ſtuff their ears and noſes to prevent the water from entering; while others uſe no precautions whatever. Although the uſual time of remaining under water does not much exceed two minutes, yet there are inſtances known of divers who could remain four and even five minutes. The longeſt inſtance ever known was that of a diver who came from Anjango in 1797, and who abſolutely remained under water full ſix minutes.

The boat-owners and merchants are very apt to loſe many of the beſt pearls while the boats are on their return to the bay from the banks, as the oyſters when alive and left for ſome time undiſturbed frequently open their ſhells of their own accord: a pearl may then be eaſily diſcovered, and the oyſter prevented by means of a bit of graſs or ſoft wood from again cloſing its ſhell, till an opportunity offers of picking out the pearl. Thoſe fellows who are employed to ſearch among the fiſh alſo commit many depredations, and even ſwallow the pearls to conceal them; when this is ſuſpected, the plan followed by the merchants is to lock the fellows up, and give them ſtrong emetics and purgatives, which have frequently the effect of diſcovering the ſtolen goods.

As ſoon as the oyſters are taken out of the boats, they are carried by the different people to whom they belong, and placed in holes or pits dug in the ground to the depth of about two feet, or in ſmall ſquare places cleared and fenced round for the purpoſe; each perſon having his own ſeparate diviſion. Mats are ſpread below them to prevent the oyſters from touching the earth; and here they are left to die and rot. As ſoon as they have paſſed through a ſtate of putrefaction, and have become dry, they are eaſily opened without any danger of injuring the pearls, which might be the caſe if they were opened freſh, as at that time to do ſo requires great force. On the ſhell being opened, the oyſter is minutely examined for the pearls: it is uſual even to boil the oyſter, as the pearl, though commonly found in the ſhell, is not unfrequently contained in the body of the fiſh itſelf.

The pearls found at this fiſhery are of a whiter colour than thoſe got in the gulf of Ormus on the Arabian coaſt, but in other reſpects are not accounted ſo pure or of ſuch an excellent quality; for though the white pearls are more eſteemed in Europe, the natives prefer thoſe of a yellowiſh or golden caſt. Off Tuticoreen, which lies on the Coromandel coaſt, nearly oppoſite to Condatchy, there is another fiſhery; but the pearls found there are much inferior to the two ſpecies now mentioned, being tainted with a blue or grayiſh tinge.

In preparing the pearls, particularly in drilling and ſtringing them, the black people are wonderfully expert. The inſtrument they employ in drilling, is a machine made of wood, and of a ſhape reſembling an obtuſe inverted cone, about ſix inches in length, and four in breadth, which is ſupported upon three feet, each 12 inches long. In the upper flat ſurface of this machine, holes or pits are formed to receive the larger pearls, the ſmaller ones being beaten in with a little wooden hammer. The drilling inſtruments are ſpindles of various ſizes according to that of the pearls; they are turned round in a wooden head by means of a bow-handle to which they are attached. The pearls being placed in the pits which we have already mentioned, and the point of the ſpindle adjuſted to them, the workman preſſes on the wooden head of the machine with his left hand, while his right is employed in turning round the bow-handle. During the proceſs of drilling, he occaſionally moiſtens the pearl by dipping the little finger of his right hand in a cocoa-nut filled with water, which is placed by him for that purpoſe; this he does with a dexterity and quickneſs which ſcarcely impedes the operation, and can only be acquired by much practice.

They have alſo a variety of other inſtruments, both for cutting and drilling the pearls. To clean, round, and poliſh them to that ſtate in which we ſee them, a powder made of the pearls themſelves is employed. Theſe different operations in preparing the pearls occupy a great number of the black men in various parts of the iſland. In the black town of Columbo, in particular, many of them may every day be ſeen at this work.

Putallom is remarkable for its ſalt-pans. This place, before the arrival of Europeans on the iſland, ſupplied the natives with ſalt; and on account of its convenient ſituation, was pitched upon by the Dutch for manufacturing the ſalt with which they ſupplied the king of Candy's dominions, according to the articles of their treaty with him. The ſalt-pans are formed by an arm of the ſea which overflows part of the country between Putallom and Calpenteen. A very large quantity of ſalt was manufactured here by the Dutch; they looked upon it as of the higheſt importance to their intereſts in the iſland, and the moſt formidable weapon which it was in their power to employ againſt the native king, as it was impoſſible for him to procure any but through their means. The Dutch enacted ſevere laws to prevent individuals from manufacturing or trading in this article, the government taking upon itſelf the management of the works and the care of ſupplying both its own ſubjects and the Candians. In order to keep a conſtant check on the latter, the Dutch were careful not to allow them too great a quantity at once; and whatever remained at Putallom after ſupplying the demands of each year they deſtroyed, that it might not be ſeized upon by ſurpriſe. But this manufacture has been greatly neglected, it is ſaid, ſince the iſland came into the poſſeſſion of the Britiſh.

CHACE. See CHASE.

CHACO, a large country of South America, ſituated between 19° and 37° S. Lat. It belongs to the Spaniards, by whom it was conquered in 1536. It is not naturally fruitful; but abounds in gold mines, which are ſo much the more valuable that they are eaſily worked. The works are carried on by about 8000 blacks, who deliver every day to their maſters a certain quantity of gold; and what they can collect above this belongs to themſelves: as well as what they find on thoſe days that are conſecrated to religion and reſt, upon condition that during the feſtival they maintain themſelves. This enables many of them to purchaſe their liberty; after which they intermarry with the Spaniards.

CHADCHOD, in Jewiſh antiquity. Ezekiel mentions *chadchod* among the ſeveral merchandiſes which were brought to Tyre. The old interpreters, not very well knowing the meaning of this term, continued it in their tranſlation. St Jerome acknowledges that he could not diſcover the interpretation of it. The Chaldee interprets it pearls; others think that the onyx, ruby, carbuncle, cryſtal, or diamond, is meant by it.

CHÆRONEA, in *Ancient Geography*, the laſt town, or rather the laſt village, of Bœotia, towards Phocis; the birth-place of Plutarch; famous for the fatal defeat of the confederate Greeks by Philip of Macedon. This place was conſidered by Philip as well adapted to the operations of the Macedonian phalanx; and the ground for his encampment, and afterwards the field of battle, were choſen with equal ſagacity; having in view on one ſide a temple of Hercules, whom the Macedonians regarded as the author of their royal houſe, and the high protecter of their fortune; and on the other the banks of the Thermodon, a ſmall river flowing into the Cephiſſus, announced by the oracles of Greece as the deſtined ſcene of deſolation and woe to their unhappy country. The generals of the confederate Greeks had been much leſs careful to avail themſelves of the powerful ſanctions of ſuperſtition. Unreſtrained by inauſpicious ſacrifices, the Athenians had left the city at the exhortation of Demoſthenes, to wait no other omen but the cauſe of their country. Regardleſs of oracles, they afterwards advanced to the ill-fated Thermodon, accompanied by the Thebans, and the ſcanty reinforcements raiſed by the iſlands and ſtates of Peloponneſus which had joined their alliance. Their army amounted to 30,000 men, animated by the nobleſt cauſe for which men can fight, but commanded by the Athenians Lyſicles and Chares; the firſt but little, and the ſecond unfavourably, known; and by Theagenes the Theban, a perſon ſtrongly ſuſpected of treachery: all three creatures of cabal and tools of faction, ſlaves of intereſt or voluptuouſneſs, whoſe characters (eſpecially as they had been appointed to command the only ſtates whoſe ſhame, rather than virtue, yet oppoſed the public enemy) are alone ſufficient to prove that Greece was ripe for ruin.

When the day approached for aboliſhing the tottering independence of thoſe turbulent republics, which their own internal vices, and the arms and intrigues of

Philip, had been gradually undermining for 22 years, both armies formed in battle array before the riſing of the ſun. The right wing of the Macedonians was headed by Philip, who judged proper to oppoſe in perſon the dangerous fury of the Athenians. His ſon Alexander, only 19 years of age, but ſurrounded by experienced officers, commanded the left wing, which faced the Sacred Band of the Thebans. The auxiliaries of either army were poſted in the centre. In the beginning of the action, the Athenians charged with impetuoſity, and repelled the oppoſing diviſions of the enemy; but the youthful ardour of Alexander obliged the Thebans to retire, the Sacred Band being cut down to a man. The young prince completed their diſorder, by purſuing the ſcattered multitude with his Theſſalian cavalry.

Meantime the Athenian generals, too much elated with their firſt advantage, loſt the opportunity to improve it; for having repelled the centre and right wing of the Macedonians, except the phalanx, which was compoſed of choſen men, and immediately commanded by the king, they, inſtead of attempting to break this formidable body by attacking it in flank, preſſed forward againſt the fugitives, the inſolent Lyſicles exclaiming in vain triumph, "Purſue, my brave countrymen! let us drive the cowards to Macedon." Philip obſerved this raſh folly with contempt; and ſaying to thoſe round him, "Our enemies know not how to conquer," commanded his phalanx, by a rapid evolution, to gain an adjacent eminence, from which they poured down, firm and collected, on the advancing Athenians, whoſe confidence of ſucceſs had rendered them totally inſenſible to danger. But the irreſiſtible ſhock of the Macedonian ſpear converted their fury into deſpair. Above a thouſand fell, two thouſand were taken priſoners; the reſt eſcaped by a precipitate and ſhameful flight. Of the Thebans more were killed than taken. Few of the confederates periſhed, as they had little ſhare in the action, and as Philip, perceiving his victory to be complete, gave orders to ſpare the vanquiſhed, with a clemency unuſual in that age, and not leſs honourable to his underſtanding than his heart; ſince his humanity thus ſubdued the minds, and gained the affections of his conquered enemies.

According to the Grecian cuſtom, the battle was followed by an entertainment; at which the king, preſiding in perſon, received the congratulations of his friends, and the humble ſupplications of the Athenian deputies, who craved the bodies of their ſlain. Their requeſt, which ſerved as an acknowledgment of their defeat, was readily granted; but before they availed themſelves of the permiſſion to carry off their dead, Philip, who with his natural intemperance had protracted the entertainment till morning, iſſued forth with his licentious companions to viſit the field of battle; their heads crowned with feſtive garlands, their minds intoxicated with the inſolence of wine and victory; yet the ſight of the ſlaughtered Thebans, which firſt preſented itſelf to their eyes, and particularly the ſacred band of friends and lovers, who lay covered with honourable wounds on the ſpot where they had been drawn up to fight, brought back theſe inſolent ſpectators to the ſentiments of reaſon and humanity. Philip beheld the awful ſcene with a mixture of admiration and pity; and, after an affecting ſilence, denounced a ſolemn curſe againſt thoſe who baſely ſuſpected the friendſhip of ſuch brave men to be tainted with criminal and infamous paſſions.

But this ſerious temper of mind did not laſt long; for having proceeded to that quarter of the field where the Athenians had fought and fallen, the king abandoned himſelf to all the levity and littleneſs of the moſt petulant joy. Inſtead of being impreſſed with a deep ſenſe of his recent danger, and with dutiful gratitude to Heaven for the happineſs of his eſcape, and the importance of his victory, Philip only compared the boaſtful pretenſions with the mean performances of his Athenian enemies; and, ſtruck by this contraſt, rehearſed, with the inſolent mockery of a buffoon, the pompous declaration of war lately drawn up by the ardent patriotiſm and too ſanguine hopes of Demoſthenes. It was on this occaſion that the orator Demades at once rebuked the folly, and flattered the ambition of Philip, by aſking him, Why he aſſumed the character of Therſites when fortune aſſigned him the part of Agamemnon?

Whatever might be the effect of this ſharp reprimand, it is certain that the king of Macedon indulged not, on any future occaſion, a vain triumph over the vanquiſhed. When adviſed by his generals to advance into Attica, and to render himſelf maſter of Athens, he only replied, "Have I done ſo much for glory, and ſhall I deſtroy the theatre of that glory?" His ſubſequent conduct correſponded with the moderation of this ſentiment. He reſtored without ranſom the Athenian priſoners; who, at departing, having demanded their baggage, were alſo gratified in this particular; the king pleaſantly obſerving, that the Athenians ſeemed to think he had not conquered them in earneſt. Soon afterwards he diſpatched his ſon Alexander, and Antipater the moſt truſted of his miniſters, to offer them peace on ſuch favourable terms as they had little reaſon to expect. They were required to ſend deputies to the iſthmus of Corinth, where, to adjuſt their reſpective contingents of troops for the Perſian expedition, Philip purpoſed aſſembling early in the ſpring a general convention of all the Grecian ſtates: they were ordered to ſurrender the iſle of Samos, which actually formed the principal ſtation of their fleet, and the main bulwark and defence of all their maritime or inſular poſſeſſions; but they were allowed to enjoy, unmoleſted, the Attic territory, with their hereditary form of government.

CHÆROPHYLLUM, CHERVIL. See BOTANY *Index*.

CHÆTODON. See ICHTHYOLOGY *Index*. This fiſh is a native of the Eaſt Indies, where it frequents the ſides of the ſea and rivers in ſearch of food; from its ſingular manner of obtaining which it receives its name. When it ſpies a fly ſitting on the plants that grow in ſhallow water, it ſwims to the diſtance of four, five, or ſix feet; and then, with a ſurpriſing dexterity, it ejects out of its tubular mouth a ſingle drop of water, which never fails ſtriking the fly into the water, where it ſoon becomes its prey.

CHAFF, in *Huſbandry*, the huſks of the corn, ſeparated by ſcreening or winnowing it. It ſignifies alſo the rind of corn, and ſtraw cut ſmall for the uſe of cattle.

CHAFF-Cutter, a machine for making chaff to feed horſes.—The advantages of an eaſy and expeditious method of cutting ſtraw into chaff, by an engine which could be uſed by common labourers, have been long acknowledged; and various attempts have been made to bring ſuch an engine to perfection. But the objections to moſt of them have been their complicated ſtructure, their great price, and the noiſe they make in working; all which inconveniences ſeem to have been lately removed by an invention of Mr James Pike, watchmaker at Newton Abbot in Devonſhire. Of his engine, which is of a ſimple and cheap conſtruction, the following deſcription, and figure referred to, are extracted from the Tranſactions of the Society of Arts, for 1787.

The engine is fixed on a wooden frame, which is ſupported with four legs, and on this frame is a box for containing the ſtraw, four feet ſix inches long; and about ten inches broad; at one end is fixed acroſs the box two rollers inlaid with iron, in a diagonal line about an eighth of an inch above the ſurface; on the ends of theſe rollers are fixed two ſtrong braſs wheels, which takes one into the other. On one of theſe wheels is a contract wheel, whoſe teeth take in a worm on a large arbor; on the end of this arbor is fixed a wooden wheel, two feet five inches diameter and three inches thick; on the inſide part of this wheel is fixed a knife, and every revolution of the wheel the knife paſſes before the end of the box and cuts the chaff, which is brought forward between the rollers, which are about two inches and a half aſunder; the ſtraw is brought on by the worm taking one tooth of the wheel every round of the knife; the ſtraw being ſo hard preſſed between the rollers, the knife cuts off the chaff with ſo great eaſe, that 22 buſhels can be cut within the hour, and makes no more noiſe than is cauſed by the knife paſſing through the chaff.

Plate CXXXVII.

A is the box into which the ſtraw is put. *B*, the upper roller, with its diagonal projecting ribs of iron, the whole moving by the revolution of the braſs wheel *C* on the axis of which it is fixed. *D*, a braſs wheel, having upon it a face wheel, whoſe teeth take into the endleſs ſcrew on the arbor *E*, while the teeth on the edge of this wheel enter between thoſe on the edge of the wheel *C*. On the axis of the wheel *D* is a roller, with iron ribs ſimilar to *B*, but hid within the box. *E*, the arbor, one of the ends of which being made ſquare and paſſing through a mortiſe in the centre of the wooden wheel *F*, is faſtened by a ſtrong ſcrew and nut; the other end of this arbor moves round in a hole within the wooden block *G*. *H*, the knife, made faſt by ſcrews to the wooden wheel *F*, and kept at the diſtance of nearly three quarters of an inch from it by means of a ſtrip of wood of that thickneſs, of the form of the blade, and reaching to within an inch of the edge. *I*, the handle mortiſed into the outſide of the wooden wheel *F*.

CHAFFER, in *Zoology*, a ſpecies of beetle. See SCARABÆUS, ENTOMOLOGY *Index*.

CHAFFERCONNERS, in commerce, printed linens manufactured in the Great Mogul's dominions. They are imported by the way of Surat, and are of the number of thoſe linens prohibited in France.

CHAFFERY, in the iron works, the name of one of the two principal forges. The other is called the *finery*. When the iron has been brought at the finery into what is called an ancony, or ſquare maſs, hammered into a bar in its middle, but with its two ends rough, the buſineſs to be done at the chaffery is the reducing the whole to the ſame ſhape, by hammering down theſe rough ends to the ſhape of the middle part.

CHAFFINCH, the Engliſh name of a ſpecies of FRINGILLA. See ORNITHOLOGY *Index*.

CHAGRE, a fort of America, in the province of Darien, at the mouth of a river of the ſame name. It has been taken ſeveral times by the Bucaniers, and laſt of all by Admiral Vernon in 1740. W. Long. 82. 7. N. Lat. 9. 50.

CHAIN (*Catena*), a ſeries of ſeveral rings or links, fitted into one another.

There are chains of divers matters, ſizes, forms, and for divers uſes.—Ports, rivers, ſtreets, &c. are cloſed with iron chains; rebellious cities are puniſhed by taking away their chains and barriers.

The arms of the kingdom of Navarre are, *Chains Or, in a field of Gules*. The occaſion hereof is referred to the kings of Spain leagued againſt the Moors; who, having gained a celebrated victory againſt them in 1212, in the diſtribution of the ſpoils the magnificent tent of Miralmumin fell to the king of Navarre, as being the firſt that broke and forced the chains thereof.

A gold CHAIN is one of the ornaments or badges of the dignity of the chief magiſtrates of a city, as the mayor of London, the provoſt and bailies of Edinburgh, &c.—Something like this obtained among the ancient Gauls: the principal ornament of their perſons in power and authority was a gold chain, which they wore on all occaſions; and even in battle, to diſtinguiſh them from the common ſoldiers.

CHAIN alſo denotes a kind of ſtring, of twiſted wire; ſerving to hang watches, tweeſer caſes, and other valuable toys upon. The invention of this piece of curious work is owing to the Engliſh; whence, in foreign countries, it is denominated the *Engliſh chain*. Theſe chains are uſually either of ſilver or gold, ſome of gilt copper; the thread or wire of each kind to be very fine.—For the fabric, or making of theſe chains; a part of the wire is folded into little links of an oval form; the longeſt diameter about three lines; the ſhorteſt one. Theſe, after they have been exactly ſodered, are again folded into two; and then bound together or interwoven, by means of ſeveral other little threads of the ſame thickneſs; ſome whereof, which paſs from one end to the other, imitate the warp of a ſtuff; and the others, which paſs tranſverſe, the woof. There are at leaſt four thouſand little links in a chain of four pendants; which are by this means bound ſo equally, and withal ſo firmly together, that the eyes is deceived, and takes the whole to conſiſt of one entire piece.

CHAIN is alſo a kind of meaſure in France, in the trade of wood for fuel. There are chains for wood by tale, for wood by the rope, for faggots, for cleft wood, and for round ſticks. There are alſo chains for meaſuring the ſheaves of all ſorts of corn, particularly with regard to the payment of tithes; for meaſuring pottles of hay, and for meaſuring horſes. All theſe are divided into feet, inches, hands, &c. according to the uſe they are deſigned for.

Chain, in ſurveying, is a meaſure, conſiſting of a certain number of links of iron wire, uſually a hundred; ſerving to take the dimenſions of fields, &c. This is what Merſenne takes to be the arvipendium of the ancients.

The chain is of various dimenſions, as the length or number of links varies: that commonly uſed in meaſuring land, called Gunter's chain, is in length four poles or perches; or ſixty-ſix feet, or a hundred links; each link being ſeven inches $\frac{92}{100}$. Whence it is eaſy to reduce any number of thoſe links to feet, or any number of feet to links.

This chain is entirely adapted to Engliſh meaſures; and its chief convenience is in finding readily the numbers contained in a given field. Where the proportions of ſquare feet and acres differ, the chain, to have the ſame advantages as Gunter's chain, muſt alſo be varied. Thus, in Scotland, the chain ought to be of 74 feet, or 24 Scotch ells, if no regard be had to the difference between the Scotch and Engliſh foot; but if regard be had to this difference, the Scotch chain ought to conſiſt of $74\frac{2}{5}$ Engliſh feet, or 74 feet four inches and $\frac{4}{5}$ of an inch. This chain being divided into an hundred links, each of theſe will be $\frac{928}{1000}$ inches.

That ordinarily uſed for large diſtances, is in length 100 feet; each link one foot. For ſmall parcels, as gardens, &c. is ſometimes uſed a ſmall chain of one pole, or 16 feet and a half length; each link one inch $\frac{98}{100}$.

Some in lieu of chains uſe ropes; but theſe are liable to ſeveral irregularities, both from the different degrees of moiſture, and of the force which ſtretches them. Schwenterus, in his Practical Geometry, tells us, he has obſerved a rope ſixteen feet long reduced to fifteen in an hour's time, by the mere falling of a hoar-froſt. To obviate theſe inconveniences, Wolfius directs, that the little ſtrands whereof the rope conſiſts be twiſted contrariwiſe, and the rope dipped in boiling hot oil, and when dry, drawn through melted wax. A rope thus prepared will not get or loſe any thing in length, even though kept under water all day.

Chain Pump. See Pump.

Chain Shot, two bullets with a chain between them. They are uſed at ſea to ſhoot down yards or maſts, and to cut the ſhrouds or rigging of a ſhip.

Top Chain, on board a ſhip, a chain to ſling the ſail yards in time of battle, in order to prevent them from falling down when the ropes by which they are hung happen to be ſhot away or rendered incapable of ſervice.

Plate CXXXVII.

Chain Wales, or *Channels*, of a ſhip, (*portehoiſſoirs*), are broad and thick planks projecting horizontally from the ſhip's outſide, abreaſt of and ſomewhat behind the maſts. They are formed to extend the ſhrouds from each other, and form the axis or middle line of the ſhip, ſo as to give a greater ſecurity and ſupport to the maſts, as well as to prevent the ſhrouds from damaging the gunwale, or being hurt by rubbing againſt it. Every maſt has its chain wales, which are either built above or below the ſecond deck ports in a ſhip of the line; they are ſtrongly connected to the ſide by knees, bolts, and ſtandards, beſides being confined thereto by the chains, whoſe upper ends paſs through notches on the outer edge of the chain wales, ſo as to unite with the ſhrouds above.

Chains, in *Ship-Building*, are ſtrong links or plates of iron, the lower ends of which are bolted through the ſhip's ſide to the timbers.

Hanging in Chains, a kind of puniſhment inflicted on murderers. By ſtat. 25. Geo. II. c. 37. the judge ſhall direct ſuch to be executed on the next day but one, unleſs Sunday intervene; and their bodies to be delivered to the ſurgeons to be diſſected and anatomized: and he may direct them afterwards to be hung in chains. During the interval between ſentence and execution, the priſoner ſhall be kept alone, and ſuſtained only with bread and water. The judge, however, hath power to reſpite the execution, and relax the other reſtraints of the act.

Chain Iſland, an iſland lately diſcovered by Captain Wallis in the South ſea. It ſeemed to be about five miles long and as much broad, lying in the direction of north-weſt and ſouth-eaſt. It appeared to be a double range of woody iſlands joined together by reefs, ſo as to compoſe one iſland of an oval figure, with a lake in the middle. The trees are large, and from the ſmoke that iſſued from the woods, it appeared to be inhabited. W. Long. 145. 54. S. Lat. 17. 23.

CHAJOTLI, or Chayoti, a Mexican fruit of a round ſhape, and ſimilar in the huſk with which it is covered to the cheſnut, but four or five times larger, and of a much deeper green colour. Its kernel is of a greeniſh white, and has a large ſtone in the middle, which is white, and like it in ſubſtance. It is boiled, and the ſtone eaten with it. This fruit is produced by a twining perennial plant, the root of which is alſo good to eat.

CHAIR, *(Cathedra)*, was anciently uſed for the pulpit, or ſuggeſtum, whence the prieſt ſpoke to the people.

It is ſtill applied to the place where profeſſors and regents in univerſities deliver their lectures, and teach the ſciences to their pupils; thus, we ſay, the profeſſor's chair, the doctor's chair, &c.

Curule Chair, was an ivory ſeat placed on a car, wherein were ſeated the prime magiſtrates of Rome, and thoſe to whom the honour of a triumph had been granted.

Sedan Chair, a vehicle ſupported by poles, wherein perſons are carried; borne by two men. There are 200 chairs allowed by act of parliament: and no perſon is obliged to pay for a hackney chair more than the rate allowed by the act for a hackney coach driven two-third parts of the ſaid diſtance. 9. Ann. c. 23. § 8. Their number is ſince increaſed by 10 Ann. c. 19. and 12 Geo. I. c. 12. to 400. See *Hackney Coaches*.

Chair is alſo applied by the Romaniſts to certain feaſts, held anciently in commemoration of the tranſlation of the ſee, or ſeat of the vicarage of Chriſt, by St Peter.

The perforated chair, wherein the new elected pope is placed, F. Mabillon obſerves, is to be ſeen at Rome: but the origin thereof he does not attribute, as is commonly done, to the adventure of Pope Joan; but ſays there is a myſtery in it; and it is intended,

tended, forſooth, to explain to the pope thoſe words of Scripture, that *God draws the poor from out of the duſt and mire.*

CHAIRMAN, the preſident, or ſpeaker of an aſſembly, company, &c. We ſay, the chairman of a committee, &c.

CHAISE, a ſort of light open chariot, or calaſh.

Aurelius Victor relates, that Trajan firſt introduced the uſe of poſt chaiſes; but the invention is generally aſcribed to Auguſtus; and was probably only improved by Trajan and ſucceeding emperors.

CHALAZA, among naturaliſts, a white knotty ſort of a ſtring at each end of an egg, formed of a plexus of the fibres of the membranes, whereby the yolk and white are connected together. See EGG.

CHALCAS. See BOTANY *Index*.

CHALCEDON, or CALCEDON, anciently known by the names of *Proceraſtis* and *Colbuſa*; a city of Bithynia, ſituated at the mouth of the Euxine, on the north extremity of the Thracian Boſphorus, over againſt Byzantium. Pliny, Strabo, and Tacitus, call it, *The City of the Blind*; alluding to the anſwer which the Pythian Apollo gave to the founders of Byzantium, who, conſulting the oracle relative to a place where to build a city, were directed to chooſe that ſpot, which lay oppoſite "to the habitation of the blind;" that is, as was then underſtood, to Chalcedon: the Chalcedonians well deſerving that epithet for having built their city in a barren and ſandy ſoil, without ſeeing that advantageous and pleaſant ſpot on the oppoſite ſhore, which the Byzantines afterwards choſe.—Chalcedon, in the Chriſtian times, became famous on account of the council which was held there againſt Eutyches. The emperor Valens cauſed the walls of this city to be levelled with the ground for ſiding with Procopius, and the materials to be conveyed to Conſtantinople, where they were employed in building the famous Valentinian aqueduct. Chalcedon is at preſent a poor place, known to the Greeks by its ancient name, and to the Turks by that of *Cadiaci*, or, "the judges town."

CHALCEDONY, in *Natural Hiſtory*, a genus of the ſemipellucid gems. They are of an even and regular, not tabulated ſtructure; of a ſemi-opaque cryſtalline baſis, and variegated with different colours, but thoſe ever diſpoſed in form of miſts or clouds, and, if nicely examined, found to be owing to an admixture of various coloured earths, but imperfectly blended in the maſs, and often viſible in diſtinct moleculæ. It has been doubted by ſome whether the ancients were at all acquainted with the ſtone we call *Chalcedony*; they having deſcribed a Chalcedonian carbuncle and emerald, neither of which can at all agree with the characters of our ſtone; but we are to conſider that they have alſo deſcribed a Chalcedonian jaſper, which ſeems to have been the very ſame ſtone as they deſcribe by the word *turbida*, which extremely well agrees with our chalcedony.

There are four known ſpecies of the chalcedony. 1. A bluiſh white one. This is the moſt common of all, and is found in the ſhape of our flints and pebbles, in maſſes of two or three inches or more in diameter. It is of a whitiſh colour, with a faint cloud of blue diffuſed all over it, but always in the greateſt degree near the ſurface. This is a little leſs hard than the oriental onyx. The oriental chalcedonies are the only ones of any value; they are found in vaſt abundance on the ſhores of rivers in all parts of the Eaſt Indies, and frequently come over among the ballaſt of the Eaſt India ſhips. They are common in Sileſia and Bohemia, and other parts of Europe alſo; but with us are leſs hard, more opaque, and of very little value. 2. The dull milky-veined chalcedony. This is a ſtone of little value; and is ſometimes met with among our lapidaries, who miſtake it for a kind of nephritic ſtone. It is of a ſomewhat yellowiſh white or cream colour, with a few milk-white veins. This is principally found in New Spain. 3. The third is a browniſh, black, dull, and cloudy one, known to the ancients by the name of ſmoky jaſper, or jaſpis capnitis. This is the leaſt beautiful ſtone of all the claſs: it is of a pale browniſh white, clouded all over with a blackiſh miſt, as the common chalcedony is with a blue. It is common both in the Eaſt and Weſt Indies, and in Germany; but is very little valued, and is ſeldom worked into any thing better than the handles of knives. 4. The yellow and red chalcedony is greatly ſuperior to all the reſt in beauty; and is in great repute in Italy, though very little known among us. It is naturally compoſed of an admixture of red and yellow only, on a clouded cryſtalline baſis; but is ſometimes found blended with the matter of common chalcedony, and then is mixed with blue. It is all over of the miſty hue of the common chalcedony. This is found only in the Eaſt Indies, and there not plentifully. The Italians make it into beads, and call theſe *caſſidonies*; but they are not determinate in the uſe of the word, but call beads of ſeveral of the agates by the ſame name. All the chalcedonies readily give fire with ſteel, and make no efferveſcence with aquafortis.

CHALCIDENE, or CHALCIDICE, in *Ancient Geography*, an inland country of Syria, having Antiochia or Seleucia to the weſt, Cyrrheſtica to the north, to the ſouth Apamene and Cœloſyria, and to the eaſt Chalybonites; being ſo called from its principal city Chalcis. This province, one of the moſt fruitful in Syria, was ſeized by Ptolemy the ſon of Mennæus during the troubles of Syria, and by him made a ſeparate kingdom. Ptolemy himſelf is ſtyled by Joſephus and Hegeſippus only prince of Chalcis, but his ſon Lyſanias is honoured both by Joſephus and Dio with the title of king. Upon the death of Antiochus Dionyſius king of Syria, Ptolemy attempted to make himſelf maſter of Damaſcus and all Cœloſyria; but the inhabitants having an utter averſion to him on account of his cruelty and wickedneſs, choſe rather to ſubmit to Aretas king of Arabia, by whom Antiochus and his whole army had been cut off. He oppoſed Pompey on his entering Syria; but was by him defeated, taken priſoner, and ſentenced to death; which, however, he eſcaped by paying a thouſand talents, and was left alſo in poſſeſſion of his kingdom. After Ariſtobulus king of Judea had been poiſoned by the friends of Pompey, and Alexander his ſon beheaded at Antioch, he ſent Philippion his ſon to Aſcalon, whither the widow of Ariſtobulus had retired with her other children, to bring them all to Chalcis; propoſing, as he was in love with one of the daughters named Alexandra, to maintain them in his own kingdom in a manner ſuitable to their rank; but Philippion likewiſe being

ing in love with Alexandra, married her on the way; for which preſumption Ptolemy put him to death on his return, and then took her to wife. On account of this affinity, he ſupported to the utmoſt of his power Antigonus the younger ſon of Ariſtobulus, who took the field at the head of a conſiderable army, but on his entering Judea was entirely defeated by Herod. Ptolemy ſoon after died, and was ſucceeded by his ſon Lyſanias, who, eſpouſing the cauſe of the Aſmonæan family with great warmth, promiſed to Barzapharnes who commanded the Parthian troops in Syria, and to Pacorus the king's ſon, a thouſand talents and five hundred women, provided they ſhould put Antigonus in poſſeſſion of the kingdom of Judea, and depoſe Hyrcanus. He was not long after put to death by Mark Antony, at the inſtigation of Cleopatra; who, in order to have his dominions, accuſed him falſely of having entered into an alliance with the Parthians.

CHALCIDIC, Chalcidicum, or Chalcedonium, in the ancient architecture, a large magnificent hall belonging to a tribunal or court of juſtice. Feſtus ſays, it took its name from the city Chalcis; but he does not give the reaſon. Philander will have it to be the court or tribunal where affairs of money and coinage were regulated; ſo called from χαλκος, *braſs*, and δικη, *juſtice*. Others ſay, the money was ſtruck in it; and derive the word from χαλκος, and οικος, *houſe*. In Vitruvius, it is uſed for the auditory of a baſilica; in others of the ancient writers for a hall or apartment where the heathens imagined their gods to eat.

CHALCIDICE, in *Ancient Geography*, an eaſtern diſtrict of Macedonia, ſtretching northwards between the Sinus Toronæus and Singiticus. Formerly a part of Thrace, but invaded by Philip of Macedon. Named from the city Chalcis near Olynthus

CHALCIDIUS, a famous Platonic philoſopher in the third century, who wrote a commentary, which is eſteemed, on the Timæus of Plato. This work has been tranſlated from the Greek into Latin.

CHALCIS, in *Ancient Geography*, a city of Chalcidice. See Chalcidice. Another of Ætolia, near the mouth of the river Evenus, on the Ionian ſea, at the foot of a cognominal mountain; and therefore called by ſome *Hypochalcis*. Another of Eubœa (Strabo), on the Euripus, the country of Lycophron the poet, one of the ſeven which formed the conſtellation Pleiades. Now *Negroponte*. E. Long. 24. 30. Lat. 38. 30. A fourth, the capital of Chalcidene in Syria; diſtinguiſhed by the ſurname *ad Belum*, a mountain or a river; and *ad Libanum*, from its ſituation (Pliny.)

CHALCITIS, one of the diviſions or diſtricts of Meſopotamia, to the ſouth of Anthemuſia, the moſt northern diſtrict, next to Armenia, and ſituated between Edeſſa and Carræ. *Chalcitis* (Pliny), an iſland oppoſite to Chalcedon.

CHALCONDYLAS, Demetrius, a learned Greek, born at Conſtantinople, left that city after its being taken by the Turks, and afterwards taught Greek in ſeveral cities in Italy. He compoſed a Greek grammar; and died at Milan in 1513.

Chalcondylas, *Laonicus*, a famous Greek hiſtorian of the 15th century, was born at Athens; and wrote an excellent hiſtory of the Turks, from Ottoman, who reigned about the year 1300, to Mahomet II. in 1453.

CHALDEA, in *Ancient Geography*, taken in a larger ſenſe, included Babylonia; as in the prophecies of Jeremiah and Ezekiel. In a reſtricted ſenſe, it denoted a province of Babylonia, towards Arabia Deſerta; called in Scripture, *The land of the Chaldeans*. Named from Chaled the fourth ſon of Nahor. See Babylonia.

CHALDEE language, that ſpoken by the Chaldeans or people of Chaldea. It is a dialect of the Hebrew.

Chaldee Paraphraſe, in the rabbinical ſtyle, is called Targum. There are three Chaldee paraphraſes in Walton's Polyglot; viz. that of Onkelos, that of Jonathan ſon of Uzziel, and that of Jeruſalem.

CHALDRON, a dry Engliſh meaſure, conſiſting of thirty-ſix buſhels, heaped up according to the ſealed buſhel kept at Guildhall, London: but on ſhipboard, twenty-one chaldrons of coals are allowed to the ſcore. The chaldron ſhould weigh two thouſand pounds.

CHALICE, the cup or veſſel uſed to adminiſter the wine in the ſacrament, and by the Roman Catholics in the maſs.

The uſe of the chalice, or communicating in both kinds, is by the church of Rome denied to the laity, who communicate only in one kind, the clergy alone being allowed the privilege of communicating in both kinds.

CHALK (*Creta*), is a white earth found plentifully in Britain, France, Norway, and other parts of Europe, ſaid to have been anciently dug chiefly in the iſland of Crete, and thence to have received its name of *Creta*. They have a very eaſy way of digging chalk in the county of Kent in England. It is there found on the ſides of hills; and the workmen undermine it ſo far as appears proper; then digging a trench at the top, as far diſtant from the edge as the undermining goes at bottom, they fill this with water, which ſoaks through in the ſpace of a night, upon which the whole flake falls down at once. In other parts of the kingdom, chalk generally lies deeper, and they are forced to dig for it at conſiderable depths, and draw it up in buckets.

Chalk is of two kinds; hard, dry, and firm, or ſoft and unctuous; both of which are adapted to various purpoſes. The hard and dry kind is much the propereſt for burning into lime; but the ſoft and unctuous chalk is the beſt for uſing as a manure for lands. Chalk, whether burnt into lime or not, is in ſome caſes an excellent manure.

Pure chalk melts eaſily with alkali and flint into a tranſparent colourleſs glaſs. With alkaline ſalts it melts ſomewhat more difficultly, and with borax ſomewhat more eaſily, than with flint or ſand. It requires about half its weight of borax and its whole weight of alkali to fuſe it. Sal mirabile, and ſandiver, which do not vitrify at all with the cryſtalline earths, form, with half their weight of chalk, the firſt a yellowiſh black, the latter a greeniſh, glaſs. Nitre, on the other hand, one of the moſt active fluxes for flint, does not perfectly vitrify with chalk. This earth notably promotes the vitrification of flint; a mixture of the two requiring leſs alkali than either of them ſeparately. If glaſs made from flint and alkali is further ſaturated with the flint, ſo as to be incapable of bearing any further addition of that earth without becoming opaque and milky, it will ſtill in a ſtrong fire take up a conſiderable proportion, one third or one-fourth of its weight, of chalk, without injury to its tranſparency: hence chalk is ſometimes made uſe of in compoſitions for glaſs, as a part of the ſalt may then be ſpared. Chalk likewiſe has a great effect in melting the ſtony matters intermixed with metallic ores, and hence might be of uſe in ſmelting ores; as indeed limeſtone is uſed for that purpoſe. But it is remarkable, that chalk, when deprived of its fixed air, and converted into limeſtone, loſes much of its diſpoſition to vitrify. It is then found to melt very difficultly and imperfectly, and to render the glaſs opaque and milky.

Chalk readily imbibes water: and hence maſſes of it are employed for drying precipitates, lakes, earthy powders that have been levigated with water, and other moiſt preparations. Its economical uſes in cleaning and poliſhing metalline or glaſs utenſils are well known. In this caſe it is powdered and waſhed from any gritty matter it may contain, and is then called *whiting*.—In medicine it is one of the moſt uſeful abſorbents and is to be looked upon ſimply as ſuch. The aſtringent virtues which ſome have attributed to it have no foundation, unleſs in as far as the earth is ſaturated with an acid, with which it compoſes a ſaline concrete manifeſtly ſubaſtringent. For the further properties of chalk, ſee CHEMISTRY *Index*.

Black CHALK, a name given by painters to a ſpecies of earth with which they draw on blue paper, &c. It is found in pieces from two to ten feet long, and from four inches to twenty in breadth, generally flat, but ſomewhat riſing in the middle, and thinner towards the edges, commonly lying in large quantities together. While in the earth, it is moiſt and flaky: but being dried, it becomes conſiderably hard and very light, but always breaks in ſome particular direction; and if attentively examined when firſt broken, appears of a ſtriated texture. To the touch it is ſoft and ſmooth, ſtains very freely, and by virtue of its ſmoothneſs makes very neat marks. It is eaſily reduced into an impalpable ſoft powder without any diminution of its blackneſs. In this ſtate it mixes eaſily with oil into a ſmooth paſte; and being diffuſed through water, it ſlowly ſettles in a black ſlimy or muddy form; properties which make its uſe very convenient to the painters, both in oil and water colours. It appears to be an earth quite different from common chalk, and rather of the ſlaty bituminous kind. In the fire it becomes white with a reddiſh caſt, and very friable, retaining its flaky ſtructure, and looking much like the white flaky maſſes which ſome ſorts of pitcoal leave in burning. Neither the chalk nor theſe aſhes are at all affected by acids.

The colour ſhops are ſupplied with this earth from Italy or Germany; though ſome parts of England afford ſubſtances nearly, if not entirely, of the ſame quality, and which are found to be equally ſerviceable both for marking and as black paints. Such particularly is the black earth called *killow*, ſaid by Dr Merret, in his *Pinax Rerum Britannicarum*, to be found in Lancaſhire, and by Mr Da Coſta, in his Hiſtory of Foſſils, to be plentiful near the top of Cay-Avon, a high hill in Merionethſhire.

Red CHALK, an earth much uſed by painters and artificers, and common in the colour ſhops. It is properly an indurated clayey ochre, and is dug in Germany, Italy, Spain, and France, but in greateſt quantity in Flanders. It is of a fine, even, and firm texture; very heavy, and very hard; of a pale red on the outſide, but of a deep duſky chocolate colour within. It adheres firmly to the tongue, is perfectly inſipid to the taſte, and makes no efferveſcence with acids.

CHALK *Land*. Barley and wheat will ſucceed very well on the better ſort of chalky land, and oats generally do well on any kind of it. The natural produce of this ſort of land in weeds, is that ſort of ſmall vetch called the *tine-tare*, with poppies, may-weed, &c. Saintfoin and hope-clover will generally ſucceed tolerably well on theſe lands; and where they are of a better ſort, the great clover will do. The beſt manure is dung, old rags, and the ſheep dung left after folding them.

CHALK *Stones*, in *Medicine*, ſignify the concretions of calcareous matter in the hands and feet of people violently afflicted with the gout. Leeuwenhoek has been at the pains of examining theſe by the microſcope. He divides them into three parts. The firſt is compoſed of various ſmall parcels of matter looking like white grains of ſand; this is harder and drier, and alſo whiter, than the reſt. When examined with large magnifiers, thoſe are found to be compoſed of oblong particles laid cloſely and evenly together: though the whole ſmall ſtones are opaque, theſe component parts of them are pellucid, and reſemble pieces of horſe-hair cut ſhort, only that they are ſomewhat pointed at both ends. Theſe are ſo extremely thin, that Mr Leeuwenhoek computes that 1000 of them placed together would not amount to the ſize of one hair of our heads. The whole ſtones in this harder part of the chalk are not compoſed of theſe particles, but there are confuſedly thrown in among them ſome broken parts of other ſubſtances, and in a few places ſome globules of blood and ſmall remains of other juices. The ſecond kind of chalky matter is leſs hard and leſs white than the former, and is compoſed of fragments or irregular parts of thoſe oblong bodies which compoſe the firſt or hardeſt kind, and theſe are mixed among tough and clear matter, and interſperſed with the ſmall broken globules of blood diſcoverable in the former, but in much greater quantity. The third kind appears red to the naked eye; and, when examined with glaſſes, is found to be a more tough and clammy white matter, in which a great number of globules of blood are interſperſed; theſe give it the red appearance it has.

CHALLENGE, a cartel or invitation to a duel or other combat*. A challenge either by word or letter, or to be the bearer of ſuch a challenge, is puniſhable by fine and impriſonment on indictment or information.

CHALLENGE, among hunters. When hounds or beagles, at firſt finding the ſcent of their game, preſently open and cry, they are ſaid to challenge.

CHALLENGE, in the *Law of England*, is an exception made to jurors†; and is either in civil or criminal caſes.

I. In *civil* caſes challenges are of two ſorts; challenges to the array, and challenges of the poll.

* See *Duel*.

† See the article *Trial*.

1. Challenges to the array are at once an exception to the whole panel, in which the jury are arrayed, or ſet in order by the ſheriff in his return; and they may be made upon account of partiality or ſome default in the ſheriff or his under-officer who arrrayed the panel. Alſo, though there be no perſonal objection againſt the ſheriff, if yet he arrays the panel at the nomination, or under the direction of either party, this is good cauſe of challenge to the array. Formerly, if a lord of parliament had a cauſe to be tried, and no knight was returned upon the jury, it was a cauſe of challenge to the array: alſo by the policy of the ancient law, the jury was to come *de vicineto*, from the neighbourhood of the vill or place where the cauſe of action was laid in the declaration: and therefore ſome of the jury were obliged to be returned from the hundred in which ſuch vill lay; and, if none were returned, the array might be challenged from defect of hundreders. For, living in the neighbourhood, theſe were ſuppoſed to know beforehand the characters of the parties and witneſſes; and therefore they better knew what credit to give to the facts alledged in evidence. But this convenience was overbalanced by another very natural and almoſt unavoidable inconvenience; that jurors, coming out of the immediate neighbourhood, would be apt to intermix their prejudices and partialities in the trial of right. And this the law was ſo ſenſible of, that it for a long time has been gradually relinquiſhing this practice; the number of neceſſary hundreders in the whole panel, which in the reign of Edward III. was conſtantly ſix, being in the time of Forteſcue reduced to four; afterwards by ſtatute 26 Eliz. c. 6. to two; and at length, by ſtatute 4 and 5 Anne, c. 16. it was entirely aboliſhed upon all civil actions, except upon penal ſtatutes, and upon thoſe alſo by the 24 Geo. II. c. 18. the jury being now only to come *de corpore comitatus*, from the body of the country at large, and not *de vicineto*, or from the particular neighbourhood. The array by the ancient law may alſo be challenged, if an alien be party to the ſuit, and upon a rule obtained by his motion to the court for a jury *de medietate linguæ*, ſuch a one be not returned by the ſheriff purſuant to the ſtatute 28 Edward III. c. 13. enforced by 8 Hen. VI. c. 29. which enacts, that where either party is an alien born, the jury ſhall be one half denizens and the other aliens (if ſo many be forthcoming in the place), for the more impartial trial; a privilege indulged to ſtrangers in no other country in the world; but which is as ancient in England as the time of King Ethelred, in whoſe ſtatute *de monticolis Walliæ* (then aliens to the crown of England), c. 3. it is ordained, that "duodeni legales homines, quorum ſex Walli et ſex Angli erunt, Anglis et Wallis jus dicunto."

2. Challenges to the polls, *in capita*, are exceptions to particular jurors; and ſeem to anſwer the *recuſatio judicis* in the civil and canon laws; by the conſtitutions of which a judge might be refuſed upon any ſuſpicion of partiality. By the laws of England alſo, in the times of Bracton and Fleta, a judge might be refuſed for good cauſe; but now the law is otherwiſe, and it is held that judges or juſtices cannot be challenged. For the law will not ſuppoſe a poſſibility of bias or favour in a judge who is already ſworn to adminiſter impartial juſtice, and whoſe authority greatly depends on that preſumption and idea. And, ſhould the fact at any time prove flagrantly ſuch, as the delicacy of the law will not preſume beforehand, there is no doubt but that ſuch miſbehaviour would draw down a heavy cenſure from thoſe to whom the judge is accountable for his conduct. But challenges to the polls of the jury (who are judges of fact) are reduced to four heads by Sir Edward Coke: *propter honoris reſpectum; propter defectum; propter affectum;* and *propter delictum.* 1. *Propter honoris reſpectum;* as, if a lord of parliament be impannelled on a jury, he may be challenged by either party, or he may challenge himſelf. 2. *Propter defectum;* as, if a juryman be an alien born, this is defect of birth; if he be a ſlave or bondman, it is defect of liberty, and he cannot be a *liber et legalis homo.* Under the word *homo* alſo, though a name common to both ſexes, the female is however excluded, *propter defectum ſexus:* except when a widow feigns herſelf with child in order to exclude the next heir, and a ſuppoſititious birth is ſuſpected to be intended; then upon the writ *de ventre inſpiciendo*, a jury of women is to be impannelled to try the queſtion whether with child or not. But the principal deficiency is defect of eſtate ſufficient to qualify him to be a juror, which depends upon a variety of ſtatutes*. 3. Jurors may be challenged *propter affectum*, for ſuſpicion of bias or partiality. This may be either a principal challenge, or to the favour. A *principal* challenge is ſuch, where the cauſe aſſigned carries with it, *prima facie*, evident marks of ſuſpicion either of malice or favour; as, that a juror is of kin to either party within the ninth degree; that he has an intereſt in the cauſe; that there is an action depending between him and the party; that he has taken money for his verdict, &c. which if true cannot be over-ruled; for jurors muſt be *omni exceptione majores.* Challenges *to the favour* are where the party hath no principal challenge; but objects only ſome probable circumſtances of ſuſpicion, as acquaintance, and the like; the validity of which muſt be left to the determination of *triors*, whoſe office is to decide whether the juror be favourable or unfavourable. 4. Challenges *propter delictum*, are for ſome crime or miſdemeanour that affects the juror's credit, and renders him infamous: As for a conviction of treaſon, felony, perjury, or conſpiracy: or if for ſome infamous offence, he hath received judgment of the pillory or the like.

II. In *criminal* caſes, challenges may be made either on the part of the king, or on that of the priſoner; and either to the whole array, or to the ſeparate polls, for the very ſame reaſons that they may be in civil cauſes. For it is here at leaſt as neceſſary as there, that the ſheriff or returning officer be totally indifferent; that, where an alien is indicted, the jury ſhould be *de medietate*, or half foreigners, if ſo many are found in the place (which does not indeed hold in treaſons, aliens being very improper judges of the breach of allegiance; nor yet in the caſe of Egyptians under the ſtatute 22 Hen. VIII. c. 10.); that on every pannel there ſhould be a competent number of hundreders; and that the particular jurors ſhould be *omni exceptione majores*, not liable to objections either *propter honoris reſpectum, propter defectum, propter affectum,* or *propter delictum.*

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* See *Blackſton's Comm.* III. 362.

Challenges on any of the foregoing accounts are ſtyled challenges *for cauſe*; which may be without ſtint, in both civil and criminal trials. But in criminal caſes, or at leaſt in capital ones, there is, *in favorem vitæ*, allowed to the priſoner an arbitrary and capricious ſpecies of challenge to a certain number of jurors, without ſhowing any cauſe at all; which is called a peremptory challenge: a proviſion full of tenderneſs and humanity to priſoners for which our laws are juſtly famous. This is grounded on two reaſons: 1. As every one muſt be ſenſible what ſudden impreſſions and unaccountable prejudices we are apt to conceive upon the bare looks and geſtures of another; and how neceſſary it is that a priſoner, when put to defend his life, ſhould have a good opinion of his jury, the want of which might totally diſconcert him; the law wills not that he ſhould be tried by any one man againſt whom he has conceived a prejudice even without being able to aſſign a reaſon for ſuch his diſlike. 2. Becauſe upon challenges for cauſe ſhown, if the reaſon aſſigned prove inſufficient to ſet aſide the juror, perhaps the bare queſtioning his indifference may ſometimes provoke a reſentment; to prevent all ill conſequences from which, the priſoner is ſtill at liberty, if he pleaſes, peremptorily to ſet him aſide.

This privilege of peremptory challenges, though granted to the priſoner, is denied to the king by the ſtatute 33 Edward I. ſtat. 4. which enacts, that the king ſhall challenge no jurors without aſſigning a cauſe certain to be tried and approved by the court. However, it is held that the king need not aſſign his cauſe of challenge till all the panel is gone through, and unleſs there cannot be a full jury without the perſons ſo challenged. And then, and not ſooner, the king's counſel muſt ſhow the cauſe, otherwiſe the juror ſhall be ſworn.

The peremptory challenges of the priſoner muſt, however, have ſome reaſonable boundary, otherwiſe he might never be tried. This reaſonable boundary is ſettled by the common law to the number of 35; that is, one under the number of three full juries. For the law judges, that 35 are fully ſufficient to allow the moſt timorous man to challenge through mere caprice; and that he who peremptorily challenges a greater number, or three full juries, has no intention to be tried at all. And therefore it deals with one who peremptorily challenges above 35, and will not retract his challenge, as with one who ſtands mute or refuſes his trial; by ſentencing him to the *peine forte et dure* in felony, and by attainting him in treaſon. And ſo the law ſtands at this day with regard to treaſon of any kind. But by ſtatute 22 Hen. VIII. c. 14. (which, with regard to felonies, ſtands unrepealed), no perſon arraigned for felony can be admitted to make more than 20 peremptory challenges.

CHALONS-sur-Saone, an ancient town of France, in Burgundy, and capital of the Chalonnois, with a citadel and biſhop's ſee. It is ſeated on the river Saone, in E. Long. 5. 7. N. Lat. 46. 47.

Chalons-Sur-Marne, a large epiſcopal town of France, in Champagne. It carries on a conſiderable trade in ſhalloons and other woollen ſtuffs. It is ſeated between two fine meadows on the rivers Marne, Mau, and Nau, in E. Long. 4. 37. N. Lat. 48. 57.

CHALONER, Sir Thomas, a ſtateſman, ſoldier, and poet, deſcended from a good family in Denbigh in Wales, was born at London about the year 1515. Having been educated in both univerſities, but chiefly at Cambridge, he was introduced at the court of Henry VIII. who ſent him abroad in the retinue of Sir Henry Knevet, ambaſſador to Charles V. and he had the honour to attend that monarch on his fatal expedition againſt Algiers in 1541. Soon after the fleet left that place, he was ſhipwrecked on the coaſt of Barbary in a very dark night: and having exhauſted his ſtrength by ſwimming, he chanced to ſtrike his head againſt a cable, which he had the preſence of mind to catch hold of with his teeth; and, with the loſs of ſeveral of them, was drawn up by it into the ſhip to which he belonged. Mr Chaloner returned ſoon after to England, and was appointed firſt clerk of the council, which office he held during the reſt of that reign. On the acceſſion of Edward VI. he became a favourite of the duke of Somerſet, whom he attended to Scotland, and was knighted by that nobleman after the battle of Muſſelburgh, in 1547. The protector's fall put a ſtop to Sir Thomas Chaloner's expectations, and involved him in difficulties. During the reign of Queen Mary, being a determined Proteſtant, he was in ſome danger; but having many powerful friends, he had the good fortune to eſcape. On the acceſſion of Queen Elizabeth, he appeared again at court; and was ſo immediately diſtinguiſhed by her majeſty, that ſhe appointed him ambaſſador to the emperor Ferdinand I. being the firſt ambaſſador ſhe nominated. His commiſſion was of great importance; and the queen was ſo well ſatisfied with his conduct, that ſoon after his return, ſhe ſent him in the ſame capacity to Spain: but Sir Thomas was by no means ſatisfied with this inſtance of her majeſty's confidence: the courts of England and Spain being at this time extremely diſſatisfied with each other, he foreſaw that his ſituation would be very diſagreeable, and ſo it proved; but Elizabeth muſt be obeyed. He embarked for Spain in 1561, and returned to London in 1564, in conſequence of a requeſt to his ſovereign, in an elegy written in imitation of Ovid. After his return, he reſided in a houſe built by himſelf in Clerkenwell cloſe, where he died in the year 1565, and was buried in St Paul's. Sir William Cecil aſſiſted as chief mourner at his funeral.

So various were the talents of Sir Thomas Chaloner, that he excelled in every thing to which he applied himſelf. He made a conſiderable figure as a poet. His poetical works were publiſhed by William Malim, maſter of St Paul's ſchool, in 1579. His capital work was that "Of reſtoring the Engliſh republic, in ten books," which he wrote when he was ambaſſador in Spain. It is remarkable, that this great man, who knew how to tranſact as well as write upon the moſt important affairs of ſtates and kingdoms, could deſcend to compoſe a *dictionary for children*, and to tranſlate from the Latin a book *Of the office of Servants*, merely for the utility of the ſubjects.

Chaloner, *Sir Thomas*, the younger, though inconſiderable as an author, deſerves to be recorded as a ſkilful naturaliſt, in an age wherein natural hiſtory was very little underſtood in this or any other country; and particularly as the founder of the alum works in Yorkſhire, which have ſince proved ſo exceedingly advantageous to the commerce of this kingdom. He was the only ſon of Sir Thomas Chaloner mentioned in the laſt article, and was born in the year 1559 Being very young at the time of his father's death, the lord treaſurer Burleigh, taking charge of his education, ſent him to St Paul's ſchool, and afterwards to Magdalen college in Oxford, where, like his father, he diſcovered extraordinary talents for Latin and Engliſh poetry. About the year 1580, he made the tour of Europe, and returned to England before 1584; for in that year, we find him a frequent attendant in the court of Queen Elizabeth. About this time he married the daughter of Sir William Fleetwood, recorder of London. In 1591 he was knighted; and, ſome time after, diſcovered the alum mines on his eſtate at Giſborough, near the river Tees in Yorkſhire (A).

Towards the latter end of the queen's reign, Sir Thomas viſited Scotland; and returning to England in the retinue of King James I. found ſuch favour in the ſight of his majeſty, that he was immediately appointed governor to Prince Henry, whom he conſtantly attended, and, when his royal pupil viſited Oxford, was honoured with the degree of maſter of arts. How he was employed after the death of the prince is not known. Some years before that event, he married a ſecond wife, the daughter of Mr William Blount of London, by whom he had ſome children. He died in the year 1615, and was buried at Chiſwick in Middleſex. His eldeſt ſon William was created a baronet in the 18th of James, anno 1640. The title was extinct in 1681. He wrote, 1. Dedication to Lord Burleigh of his father's poetical works, dated 1579. 2. The virtue of nitre, wherein is declared the ſundry cures by the ſame effected. Lond. 1584, 4to.

CHALYBEAT, in *Medicine*, an appellation given to any liquid, as wine or water, impregnated with particles of iron or ſteel. See MINERAL WATERS.

CHALYBES, in *Ancient Geography*, an ancient people of the Hither Aſia. Their ſituation is differently aſſigned; Strabo placing them in Paphlagonia, to the eaſt of Synope; Apollonius Rhodius and Stephanus, on the eaſt of the Thermodon, in Pontus; called *Halizones*, by Homer. They either gave their name to, or took it from, their iron manufactures (Xenophon, Val. Flaccus), their only ſupport, their ſoil being barren and ungrateful, (Dionyſius Periegetes).

CHAM, or KHAN, the title given to the ſovereign princes of Tartary.

The word, in the Perſian, ſignifies *mighty lord*; in the Sclavonic, *emperor*. Sperlingius, in his diſſertation on the Daniſh term of *majeſty*, *koning*, *king*, thinks the Tartarian *cham* may be well derived from it; adding, that in the north they ſay *kan*, *konnen*, *konge*, *koning*, &c. The term *cham* is alſo applied, among the Perſians, to the great lords of the court, and the governors of provinces.

CHAM, in *Geography*, a town of the Bavarian palatinate, ſituated on a river of the ſame name, about 25 miles north-eaſt of Ratiſbon. E. Long. 13. N. Lat. 49. 15.

CHAMA, in *Zoology*, a genus of ſhell fiſh belonging to the order of vermes teſtaceæ. The ſhell is thick, and has two valves; it is an animal of the oyſter kind. Linnæus enumerates 14 ſpecies, principally diſtinguiſhed by the figure of their ſhells.

CHAMADE, in *War*, a certain beat of a drum, or ſound of a trumpet, which is given the enemy as a ſignal to inform them of ſome propoſitions to be made to the commander, either to capitulate, to have leave to bury their dead, make a truce, or the like.—Menage derives the word from the Italian *chiamata*, or *clamare*, "to cry."

CHAMÆDRYS. See VERONICA, BOTANY *Index*.

CHAMÆPITYS. See TEUCRIUM, BOTANY *Index*.

CHAMÆROPS. See BOTANY *Index*.

This plant the Americans call *thatch*, from the uſe to which the leaves are applied.—Under the name of palmetto, however, Mr Adanſon deſcribes a ſpecies of palm which grows naturally at Senegal, whoſe trunk riſes from 50 to 60 feet in height: from the upper end of the trunk iſſues a bundle of leaves, which, in turning off, form a round head: each leaf repreſents a fan of five or ſix feet in expanſion, ſupported by a tail of the ſame length. Of theſe trees ſome produce male flowers, which are conſequently barren; others are female, and loaded with fruit, which ſucceed each other uninterruptedly almoſt the whole year round. The fruit of the large palmettos, Mr Adanſon affirms to be of the bigneſs of an ordinary melon, but rounder: it is enveloped in two ſkins, as tough as leather, and as thick as ſtrong parchment; within the fruit is yellowiſh, and full of filaments faſtened to three large kernels in the middle. The negroes are very fond of this fruit, which, when baked under the aſhes, is ſaid to taſte like a quince.

CHAMANIM, in the Jewiſh antiquities, is the Hebrew name for that which the Greeks call *Pyreia* or *Pyrateria*; and St Jerome in Leviticus has tranſlated *ſimulachra*, in Iſaiah, *delubra*. Theſe chamanim were, according to Rabbi Solomon, idols expoſed to the ſun upon the tops of houſes. Abenezoa ſays they were portable chapels or temples made in the form of chariots, in honour of the ſun. What the Greeks call Pyreia were temples conſecrated to the ſun and fire, wherein a perpetual fire was kept up. They were built upon eminences; and were large encloſures without

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(A) Sir Thomas, during his reſidence in Italy, being particularly fond of natural hiſtory, ſpent ſome time at Puzzoli, where he was very attentive to the art of producing alum. This attention proved infinitely ſerviceable to his country, though of no great benefit to himſelf or his family, his attempt being attended with much difficulty and expence. It was begun about the year 16 0, in the reign of Queen Elizabeth; but was not brought to any degree of perfection till ſome time in the reign of Charles I. by the aſſiſtance of one Ruſſel a Walloon, and two other workmen brought from the alum works at Rochelle. By one of the arbitrary acts of Charles, it was then deemed a mine royal, and granted to Sir Paul Pindar. The long parliament adjudged it a monopoly, and juſtly reſtored it to the original proprietors.

out covering, where the ſun was worſhipped. The Guebres, or worſhippers of fire, in Perſia and the Eaſt Indies, have ſtill theſe Pyreia. The word *chamanim* is derived from *Chaman*, which ſignified to warm or burn.

CHAMARIN, a word which occurs in ſeveral places of the Hebrew Bible, and is generally tranſlated the *prieſts of the idols*, or the *prieſts clothed in black*, becauſe *chamar* ſignifies "black," or "blackneſs." St Jerome, in the ſecond book of Kings, renders it *aruſpices.* In Hoſea and Zephaniah, he tranſlates it *æditui* or church-wardens. But the beſt commentators are of opinion; that by this word we are to underſtand the prieſts of the falſe gods, and in particular the worſhippers of fire; becauſe they were, as they ſay, dreſſed in black; or perhaps the Hebrews gave them this name in deriſion, becauſe, as they were continually employed in taking care about the fuel, and keeping up the fire, they were always as black as ſmiths or colliers. We find prieſts, among thoſe of Iſis, called *melanephori*, that is to ſay, that wear black; but whether this may be by reaſon of their dreſſing in black, or whether it were becauſe they wore a certain ſhining black veil in the proceſſions of this goddeſs, is not certain. *Camar*, in Arabic, ſignifies the "moon." Iſis is the ſame deity. Grotius thinks the Roman prieſts, called *camilli*, came from the Hebrew *chamarin*. Thoſe among the heathens who ſacrificed to the infernal gods were dreſſed in black.

CHAMBER, in building, a member of a lodging, or piece of an apartment, ordinarily intended for ſleeping in; and called by the Latins *cubiculum*. The word comes from the Latin *camera*; and that, according to *Nicod*, from the Greek καμαρα, *vault* or *curve*; the term *chamber* being originally confined to places arched over.

A complete apartment is to conſiſt of a hall, antichamber, *chamber*, and cabinet.

Privy CHAMBER. Gentlemen of the privy chamber, are ſervants of the king, who are to wait and attend on him and the queen at court, in their diverſions, &c. Their number is forty eight, under the lord Chamberlain, twelve of whom are in quarterly waiting, and two of theſe lie in the privy chamber.

In the abſence of the lord chamberlain, or vice chamberlain, they execute the king's orders: at coronations. two of them perſonate the dukes of Aquitain and Normandy; and ſix of them, appointed by the lord chamberlain, attend ambaſſadors from crowned heads to their audiences, and in public entries. The gentlemen of the privy chamber were inſtituted by Henry VII.

CHAMBER, in *Policy*, the place where certain aſſemblies are held, alſo the aſſemblies themſelves. Of theſe ſome are eſtabliſhed by the adminiſtration of juſtice, others for commercial affairs.

Of the firſt kind are, 1. Star chamber, ſo called becauſe the roof was painted with ſtars; the authority, power, and juriſdiction of which, are abſolutely aboliſhed by the ſtatute 17 Car. I. 2. Imperial chamber of Spire, the ſupreme court of judicatory in the empire, erected by Maximilian I. This chamber has a right of judging by appeal: and is the laſt reſort of all civil affairs of the ſtates and ſubjects of the empire, in the ſame manner as the aulic council of Vienna. Nevertheleſs it is reſtrained in ſeveral caſes: it takes no notice of matrimonial cauſes, theſe being left to the pope: nor of criminal cauſes, which either belong to particular princes or towns in their reſpective territories, or are cognizable by all the ſtates of the empire in a diet. By the treaty of Oſnaburg, in 1648, fifty aſſeſſors were appointed for this chamber, whereof 24 were to be Proteſtants, and 26 Catholics; beſides five preſidents, two of them Proteſtants, and the reſt Catholics. 3. Chamber of accounts, a ſovereign court in France, where accounts are rendered of all the king's revenues, inventories, and avowals thereof regiſtered; oaths of fidelity taken, and other things relating to the finances tranſacted. There are nine in France: that of Paris is the chief; it regiſters proclamations, treaties of peace, naturalizations, titles of nobility, &c. All the members wear long black gowns of velvet, of ſatin, or damaſk, according to their places. 4. Eccleſiaſtical chambers in France, which judge by appeal of differences about collecting the tythes. 5. Chamber of audience, or grand chamber, a juriſdiction in each parliament of France, the counſellors of which are called *jugeurs*, or judges, as thoſe of the chamber of inqueſts are called *raporteurs*, reporters of proceſſes by writing. 6. Chamber of the edict, or miparty, a court eſtabliſhed by virtue of the edict of pacification in favour of thoſe of the reformed religion. This chamber is now ſuppreſſed. 7. Apoſtolical chamber of Rome, that wherein affairs relating to the revenues of the church and the pope are tranſacted. This council conſiſts of the cardinal camerlinga, the governor of the rota, a treaſurer, an auditor, a preſident, one advocate-general, a ſolicitor-general, a commiſſary, and twelve clerks. 8. Chamber of London, an apartment in Guildhall, where the city-money is depoſited.

Of the laſt ſort are, the chambers of commerce; the chambers of aſſurance; and the royal or ſyndical chamber of bookſellers in France.

1. The chamber of commerce is an aſſembly of merchants and traders, where the affairs relating to trade are treated of. There are ſeveral eſtabliſhed in moſt of the chief cities of France; and in our own country we have lately ſeen chambers of this kind erected, particularly in London, Edinburgh, and Glaſgow. 2. Chamber of aſſurance in France, denotes a ſociety of merchants and others for carrying on the buſineſs of inſuring: but in Holland it ſignifies a court of juſtice, where cauſes relating to inſurances are tried. 3. Chamber of bookſellers in Paris, an aſſembly conſiſting of a ſyndic and aſſiſtants, elected by four delegates from the printers, and twelve from the bookſellers, to viſit the books imported from abroad, and to ſearch the houſes of ſellers of marbled paper, printſellers, and dealers in printed paper for hangings, who are prohibited from keeping any letters proper for printing books. In the viſitation of books, which ought to be performed by three perſons at leaſt from among the ſyndic and aſſiſtants, all libels againſt the honour of God, and the welfare of the ſtate, and all books printed either within or without the kingdom in breach of their regulations and privileges, are ſtopt, even with the merchandiſes that may happen to be in the bales with ſuch libels or other prohibited books.

The days appointed for this chamber to meet are Tueſdays and Fridays, at two o'clock in the afternoon.

Chamber, in military affairs. 1. Powder chamber, or bomb chamber; a place ſunk under ground for holding the powder, or bombs, where they may be out of danger, and ſecured from the rain. 2. Chamber of a mine; the place, moſt commonly of a cubical form, where the powder is confined. 3. Chamber of a mortar; that part of the chaſe, much narrower than the reſt of the cylinder, where the powder lies. It is of different forms; ſometimes like a reverſed cone; ſometimes globular, with a neck for its communication with the cylinder, whence it is called a bottled chamber; but moſt commonly cylindrical, that being the form which is found by experience to carry the ball to the greateſt diſtance.

CHAMBERLAIN, an officer charged with the management and direction of a chamber. See Chamber, in *policy*.

There are almoſt as many kinds of chamberlains as chambers; the principal whereof are as follows:

Lord Chamberlain of Great Britain, the ſixth great officer of the crown; to whom belong livery and lodging in the king's court; and there are certain fees due to him from each archbiſhop or biſhop when they perform their homage to the king, and from all peers at their creation or doing their homage. At the coronation of every king, he is to have forty ells of crimſon velvet for his own robes. This officer, on the coronation day, is to bring the king his ſhirt, coif, and wearing clothes; and after the king is dreſſed, he claims his bed, and all the furniture of his chamber, for his fees: he alſo carries, at the coronation, the coif, gloves, and linen, to be uſed by the king on that occaſion; alſo the ſword and ſcabbard; the gold to be offered by the king, and the robes royal and crown: he dreſſes and undreſſes the king on that day, waits on him before and after dinner, &c. To this officer belongs the care of providing all things in the houſe of lords, in the time of parliament; to him alſo belongs the government of the palace of Weſtminſter: he diſpoſes likewiſe of the ſword of ſtate, to be carried before the king, to what lord he pleaſes.

The great chamberlain of Scotland was ranked by King Malcolm, as the third great officer of the crown, and was called *Camerarius Domini Regis*. Before a treaſurer was appointed, it was his duty to collect the revenue of the crown; and he diſburſed the money neceſſary for the king's expences, and the maintenance of the king's houſehold. From the time that a treaſurer was appointed, his province was limited to the boroughs throughout the kingdom, where he was a ſort of juſtice general, as he had a power for judging of all crimes committed within the borough, and of the crime of foreſtalling. He was to hold chamberlain ayres every year. He was ſupreme judge; nor could any of his decrees be queſtioned by any inferior judicatory. His ſentences were put in execution by the magiſtrates of the boroughs. He alſo regulated the price of proviſions within the borough, and the fees of the workmen in the mint houſe. His ſalary was only 200l. a-year. The ſmallneſs of his ſalary, and his great powers, had no doubt been the cauſes of much oppreſſion in this officer, and the chamberlain ayre was called rather a legal robbery than a court of juſtice; and when the combined lords ſeized King James VI. Auguſt 24. 1582, and carried him to Ruthven Caſtle, they iſſued a proclamation in the king's name, diſcharging the chamberlain ayres to be kept. The chamberlain had great fees ariſing from the profits of eſcheats, fines, tolls, and cuſtoms. This office was granted heritably to the family of Stuart duke of Lenox: and when their male line failed, King Charles II. conferred it in like manner upon his natural ſon, whom he created duke of Monmouth, and on his forfeiture it went to the duke of Lenox; but that family ſurrendered the office to the crown in 1703.

Lord Chamberlain of the Houſehold, an officer who has the overſight and direction of all officers belonging to the king's chambers, except the precinct of the king's bedchamber.

He has the overſight of the officers of the wardrope at all his majeſty's houſes, and of the removing wardrobes, or of beds, tents, revels, muſic, comedians, hunting, meſſengers, &c. retained in the king's ſervice. He moreover has the overſight and direction of the ſerjeants at arms, of all phyſicians, apothecaries, ſurgeons, barbers, the king's chaplains, &c. and adminiſters the oath to all officers above ſtairs.

Other chamberlains are thoſe of the king's court of exchequer, of North Wales, of Cheſter, of the city of London, &c. in which caſes this officer is generally the receiver of all rents and revenues belonging to the place whereof he is chamberlain.

In the exchequer there are two chamberlains, who keep a controlment of the pells of receipts and exitus, and have certain keys of the treaſury, records, &c.

Chamberlain of London keeps the city money, which is laid up in the chamber of London: he alſo preſides over the affairs of maſters and apprentices, and makes free of the city, &c.

His office laſts only a year; but the cuſtom uſually obtains to re-chooſe the ſame perſon, unleſs charged with any miſdemeanour in his office.

CHAMBERLAYNE, Edward, deſcended from an ancient family, was born in Glouceſterſhire 1616, and made the tour of Europe during the diſtractions of the civil war. After the Reſtoration, he went as ſecretary with the earl of Carliſle, who carried the order of the Garter to the king of Sweden; was appointed tutor to the duke of Grafton, natural ſon of Charles II. and was afterwards pitched on to inſtruct Prince George of Denmark in the Engliſh tongue. He died in 1703, and was buried in a vault in Chelſea churchyard: his monumental inſcription mentions ſix books of his writing; and that he was ſo deſirous of doing ſervice to poſterity, that he ordered ſome copies of his books to be covered with wax, and buried with him. That work by which he is beſt known, is his *Angliæ Notitiæ*, or *the Preſent State of England*, which has been often ſince printed.

Chamberlayne, *John*, ſon to the author of "The Preſent State of England," and continuator of that uſeful work, was admitted into Trinity College, Oxford, 1685; but it doth not appear that he took any degree. Beſide the *Continuation* juſt mentioned, he was author of "Diſſertations hiſtorical, critical, theological, and moral, on the moſt memorable events of the Old and New Teſtaments, with Chronological Tables;" one vol. folio ; and tranſlated a variety of works from the French, Dutch, and other languages. He likewiſe was F. R. S and communicated ſome pieces, inſerted in the Philoſophical Tranſactions. It was ſaid of him that he undeſtood ſixteen languages ; but it is certain that he was maſter of the Greek, Latin, French, High and Low Dutch, Portugueſe, and Italian. Though he was qualified for employment, he had none but that of gentleman uſher to George prince of Denmark. After a uſeful and well-ſpent life, he died in the year 1724. He was a very pious and good man, and earneſt in promoting the advancement of religion, and the intereſt of true Chriſtianity; for which purpoſe he kept a large correſpondence abroad.

CHAMBERRY, a conſiderable and populous town of Italy, in Savoy, with a caſtle. It is capital of the duchy, and well built, but has no fortifications. It is watered by ſeveral ſtreams, which have their ſources in St Martin's hill, and run through ſeveral of the ſtreets. There are piazzas under moſt part of the houſes, where people may walk dry in the worſt weather. It hath large and handſome ſuburbs; and in the centre of the town is the royal palace. The parliament meet here, which is compoſed of four preſidents, and a pretty large number of ſenators, being the ſupreme tribunal of the whole duchy. The principal church is St Leger, and the Jeſuits college is the moſt magnificent of all the monaſteries. E. Long. 5. 50. N. Lat. 45. 25.

CHAMBERS, David, a Scots hiſtorian, prieſt, and lawyer, was born in the ſhire of Roſs, about the year 1530, and educated in the univerſity of Aberdeen. From thence he went to France and Italy, where he continued ſome time, particularly at Boulogne, where, in 1556, he was a pupil of Marianus Sozenus.

After his return to Scotland, he was appointed, by Queen Mary, parſon of Suddy and chancellor of Roſs. He was ſoon after employed in digeſting the laws of Scotland, and was principally concerned in publiſhing the acts of parliament of that kingdom by authority in 1566. He was alſo appointed one of the lords of ſeſſion, and continued her majeſty's faithful ſervant till her declining fortune obliged her adherents to ſeek for refuge in other kingdoms. Chambers went firſt to Spain, where he was graciouſly received by King Philip ; and thence he travelled to Paris, where he was no leſs kindly received by Charles IX. of that kingdom, to whom, in 1572, he preſented his hiſtory of Scotland, &c. He died at Paris in the year 1592, much regretted (ſays Mackenzie) by all who knew him. His writings were chiefly calculated to aſſiſt his royal miſtreſs, and to extol the wiſdom of the Scots nation.

Chambers, *Ephraim*, author of the Scientific Dictionary which goes under his name, was born at Milton, in the county of Weſtmoreland. His parents were diſſenters of the Preſbyterian perſuaſion ; and his education no other than that common one which is intended to qualify a youth for trade and commerce. When he became of a proper age, he was put apprentice to Mr Senex the globe-maker, a buſineſs which is connected with literature, and eſpecially with aſtronomy and geography. It was during Mr Chambers's reſidence with this ſkilful mechanic, that he contracted that taſte for ſcience and learning which accompanied him through life, and directed all his purſuits. It was even at this time that he formed the deſign of his grand work, the "Cyclopædia ;" and ſome of the firſt articles of it were written behind the counter. Having conceived the idea of ſo great an undertaking, he juſtly concluded that the execution of it would not conſiſt with the avocations of trade ; and therefore he quitted Mr Senex, and took chambers at Gray's Inn, where he chiefly reſided during the reſt of his days. The firſt edition of the *Cyclopædia*, which was the reſult of many years intenſe application, appeared in 1728, in two vols folio. It was publiſhed by ſubſcription, the price being 4 l. 4 s. ; and the liſt of ſubſcribers was very reſpectable. The dedication, which was to the king, is dated October 15. 1727. The reputation that Mr Chambers acquired by his execution of this undertaking, procured him the honour of being elected F. R. S. November 6. 1729. In leſs than ten years time a ſecond edition became neceſſary; which accordingly was printed, with corrections and additions, in 1738 ; and was followed by a third the very next year.

Although the Cyclopædia was the grand buſineſs of Mr Chambers's life, and may be regarded as almoſt the ſole foundation of his fame, his attention was not wholly confined to this undertaking. He was concerned in a periodical publication, entitled, "The Literary Magazine," which was begun in 1735. In this work he wrote a variety of articles, and particularly a review of Morgan's "Moral Philoſophy." He was engaged likewiſe, in conjunction with Mr John Martyn, F. R. S. and profeſſor of botany at Cambridge, in preparing for the preſs a tranſlation and abridgment of the "Philoſophical Hiſtory and Memoirs of the Royal Academy of Sciences at Paris, or an Abridgment of all the Papers relating to Natural Philoſophy, which have been publiſhed by the Members of that illuſtrious Society." This undertaking, when completed, was compriſed in five volumes, 8vo, which did not appear till 1742, ſome time after our author's deceaſe, when they were publiſhed under the joint names of Mr Martyn and Mr Chambers. Mr Martyn, in a ſubſequent publication, hath paſſed a ſevere cenſure upon the ſhare which his fellow-labourer had in the abridgment of the Pariſian papers. The only work beſides, that we find aſcribed to Mr Chambers, is a tranſlation of the *Jeſuit's Perſpective*, from the French ; which was printed in 4to, and hath gone through ſeveral editions. Mr Chambers's cloſe and unremitting attention to his ſtudies at length impaired his health, and obliged him occaſionally to take a lodging at Canonbury-houſe, Iſlington. This not having greatly contributed to his recovery, he made an excurſion to the ſouth of France, but did not reap that benefit from it which he had himſelf hoped, and his friends wiſhed. Returning to England, he died at Canonbury-houſe, and was buried at Weſtminſter ; where the following inſcription, written by himſelf, is placed on the north ſide of the cloiſters of the Abbey :

Multis pervulgatis,
Paucis notus ;
Qui vitam, inter lucem et umbram,
Nec eruditus, nec idiota,

Literis deditus, tranſegit ; ſed ut homo
Qui humani nihil à ſe alienum putat.
Vita ſimul, et laboribus functus,
Hic requieſcere voluit,
Ephraim Chambers, R. S. S.
Obiit xv Maii, MDCCXL.

After the author's death two more editions of his Cyclopædia were publiſhed. A ſupplement, which extended to two volumes more, was afterwards compiled : and in the year 1778 was publiſhed an edition of both, incorporated into one alphabet, by Dr Rees, which was completed in four volumes folio. Another edition which is now (1803) going on, and is to extend to 20 vols. 4to, has been undertaken by the ſame gentleman.

CHAMBRE, Martin Cureau de la, phyſician in ordinary to the French king, was diſtinguiſhed by his knowledge in medicine, philoſophy, and polite learning. He was born at Mons, and was received into the French academy in 1635, and afterwards into the academy of ſciences. He wrote a great number of works ; the principal of which are, 1. The characters of the paſſions. 2. The art of knowing men. 3. On the knowledge of beaſts, &c. He died at Paris in 1669.

CHAMELEON. See Lacerta, Erpetology *Index*.

CHAMFERING, in *Architecture*, a phraſe uſed for cutting any thing aſlope on the under ſide.

CHAMIER, Daniel, an eminent Proteſtant divine, born in Dauphiny. He was many years preacher at Montellimart ; from whence he went in 1612 to Montaubon, to be profeſſor of divinity in that city, and was killed by a cannon ball during the ſiege in 1621. The moſt conſiderable of his works is his *Panſtratia Catholica*, or, "Wars of the Lord," in four volumes folio; in which he treats very learnedly of the controverſies between the Proteſtants and Roman Catholics.

CHAMOIS, or Chamois goat, in *Zoology*. See Capra, Mammalia *Index*.

CHAMOMILE. See Anthemis, Botany *Index*.

CHAMOS, or Chemosh, the idol or god of the Moabites.

The name of *chamos* comes from a root which, in Arabic, ſignifies to *make haſte* ; for which reaſon many believe Chamos to be the ſun, whoſe precipitate courſe might well procure it the name of ſwift or ſpeedy. Others have confounded Chamos with the god *Hammon*, adored not only in Libya and Egypt, but alſo in Arabia, Ethiopia, and the Indies. Macrobius ſhows that Hammon was the ſun ; and the horns, with which he was repreſented, denoted his rays. Calmet is of opinion that the god Hamonus, and Apollo Chomeus, mentioned by Strabo and Ammianus Marcellinus, was the very ſame as Chamos or the ſun. Theſe deities were worſhipped in many of the eaſtern provinces. Some who go upon the reſemblance of the Hebrew term *chamos* to that of the Greek *comos*, have believed Chamos to ſignify the god Bacchus, the god of drunkenneſs, according to the ſignification of the Greek *comos*. St Jerome, and with him moſt other interpreters, take Chamos and Peor for the ſame deity. But it ſeems that Baal Peor was the ſame as Tammuz or Adonis ; ſo that Chamos must be the god whom the heathens call the ſun.

CHAMOUNI, one of the elevated valleys of the Alps, ſituated at the foot of Mount Blanc. See Alps and Blanc.

The firſt ſtrangers whom a curioſity to viſit the glaciers drew to Chamouni (M. Sauſſure obſerves), certainly conſidered this valley as a den of robbers ; for they came armed cap-a-pee, attended with a troop of domeſtics armed in the ſame manner : they would not venture into any houſe ; they lived in tents which they had brought along with them; fires were kept burning, and centinels on guard, the whole night over. It was in the year 1741 that the celebrated traveller Pocock, and another Engliſh gentleman called Wyndham, undertook this intereſting journey. It is remembered by the old men of Chamouni, and they ſtill laugh at the fears of the travellers, and at their unneceſſary precautions. For 20 or 25 years after this period, the journey was made but ſeldom, and then chiefly by Engliſhmen, who lodged with the curate : for, when I was there in 1760, and even for four or five years afterwards, there was no habitable houſe except one or two miſerable inns, like thoſe in villages that are little frequented. But now that this expedition has gradually become ſo faſhionable, three large and good inns, which have been ſucceſſively built, are hardly ſufficient to contain the travellers that come during the ſummer from all quarters.

This concourſe of ſtrangers, and the money they leave behind them at Chamouni, have ſomewhat affected the ancient ſimplicity of the inhabitants, and even the purity of their manners. Nobody, however, has any thing to fear from them : the moſt inviolable fidelity is obſerved with reſpect to travellers; they are only expoſed to a few importunate ſolicitations, and ſome ſmall artifices dictated by the extreme eagerneſs with which the inhabitants offer their ſervices as guides.

The hope of obtaining this employment brings together, round a traveller, almoſt all the men in every village, through which he paſſes, and makes him believe that there are a great many in the valley ; but there are very few at Chamouni in ſummer. Curioſity, or the hope of making money, draws many to Paris and into Germany : beſides, as the ſhepherds of Chamouni have the reputation of excelling in the making of cheeſe, they are in great requeſt in the Tarentaiſe, in the valley of Aoſte, and even at greater diſtances ; and they receive there, for four or five months in ſummer, very conſiderable wages. Thus the labours of the field devolve almoſt entirely on the women, even ſuch as in other countries fall ſolely on the men ; as mowing, cutting of wood, and thraſhing : even the animals of the ſame ſex are not ſpared, for the cows there are yoked in the plough.

The only labours that belong excluſively to the men are the ſeeking for rock cryſtal and the chaſe. Happily they are now leſs employed than formerly in the firſt of theſe occupations ; I ſay happily, for many of them periſhed in this purſuit. The hope of enriching themſelves quickly by the diſcovery of a cavern filled with fine cryſtals, was ſo powerful a motive, that they expoſed themſelves in the ſearch to the moſt alarming dangers; and hardly a year paſſed without ſome of them periſhing in the ſnows, or among the precipices.

The principal indication of the grottoes, or cryſtal ovens as they are here called, are veins of quartz, which appear on the outſide of the rocks of granite, or of the laminated rock. Theſe white veins are ſeen at a diſtance, and often at great heights, on vertical and inacceſſible places. The adventurers endeavour to arrive at theſe, either by fabricating a road acroſs the rocks, or by letting themſelves down from above ſuſpended by ropes. When they reach the place, they gently ſtrike the rock; and if the ſtone returns a hollow ſound, they endeavour to open it with a hammer, or to blow it up with powder. This is the principal method of ſearching: but young people, and even children, often go in queſt of theſe cryſtals over the glaziers, where the rocks have lately fallen down. But whether they conſider theſe mountains as nearly exhauſted, or that the quantity of cryſtal found at Madagaſcar has too much lowered the price of this foſſil, there are now but few people that go in ſearch of it, and perhaps there is not a ſingle perſon at Chamouni that makes it his only occupation. They go however occaſionally, as to a party of pleaſure.

But the chaſe of the chamois goat, as dangerous, and perhaps more ſo than the ſeeking for cryſtal, ſtill occupies many inhabitants of the mountains, and carries off, in the flower of their age, many men whoſe lives are moſt valuable to their families. And when we are informed how this chaſe is carried on, we will be aſtoniſhed that a courſe of life, at once ſo laborious and perilous, ſhould have irreſiſtible attractions for thoſe who have been accuſtomed to it.

The chamois hunter generally ſets out in the night, that he may reach by break of day the moſt elevated paſtures where the goats come to feed, before they arrive. As ſoon as he diſcovers the place where he hopes to find them, he ſurveys it with his glaſs. If he finds none of them there, he proceeds, always aſcending; whenever he deſcries any, he endeavours to get above them, either by ſtealing along ſome gully, or getting behind ſome rock or eminence. When he is near enough to diſtinguiſh their horns, which is the mark by which he judges of the diſtance, he reſts his piece on a rock, takes his aim with great compoſure, and rarely miſſes. This piece is a rifle-barrelled carabine, into which the ball is thruſt, and theſe carabines often contain two charges, though they have but one barrel; the charges are put one above another, and are fired in ſucceſſion. If he has wounded the chamois, he runs to his prey, and for ſecurity he hamſtrings it; then he conſiders his way home: if the road is difficult, he ſkins the chamois, and leaves the carcaſs; but, if it is practicable, he throws the animal on his ſhoulders, and bears him to his village, though at a great diſtance, and often over frightful precipices: he feeds his family with the fleſh, which is excellent, eſpecially when the creature is young; and he dries the ſkins for ſale.

But if, as is the moſt common caſe, the vigilant chamois perceives the approach of the hunter, he immediately takes flight among the glaciers, through the ſnows, and over the moſt precipitous rocks. It is particularly difficult to get near theſe animals when there are ſeveral together; for then one of them, while the reſt are feeding, ſtands as a centinel on the point of ſome rock that commands a view of the avenues leading to the paſture; and as ſoon as he perceives any object of alarm, he utters a ſort of hiſs; at which the others inſtantly gather round him to judge for themſelves of the nature of the danger: if it is a wild beaſt, or a hunter, the moſt experienced puts himſelf at the head of the flock, and away they fly, ranged in a line, to the moſt inacceſſible retreats.

It is here that the fatigues of the hunter begin; inſtigated by his paſſion for the chaſe, he is inſenſible to danger: he paſſes over ſnows, without thinking of the horrid precipices they conceal; he entangles himſelf among the moſt dangerous paths, and bounds from rock to rock, without knowing how he is to return. Night often ſurpriſes him in the midſt of his purſuit; but he does not for that reaſon abandon it; he hopes that the ſame cauſe will arreſt the flight of the chamois, and that he will next morning overtake them. Thus he paſſes the night, not at the foot of a tree, like the hunter of the plain; not in a grotto ſoftly reclined on a bed of moſs; but at the foot of a rock, and often on the bare points of ſhattered fragments, without the ſmalleſt ſhelter. There, all alone, without fire, without light, he draws from his bag a bit of cheeſe, with a morſel of oaten bread, which make his common food; bread ſo dry, that he is ſometimes obliged to break it between two ſtones, or with the hatchet he carries with him to cut out ſteps in the ice. Having thus made his ſolitary and frugal repaſt, he puts a ſtone below his head for a pillow, and goes to ſleep, dreaming on the route which the chamois may have taken. But ſoon he is awakened by the freſhneſs of the morning; he gets up, benumbed with cold; ſurveys the precipices which he muſt traverſe, in order to overtake his game; drinks a little brandy, of which he is always provided with a ſmall portion, and ſets out to encounter new dangers. Hunters ſometimes remain in theſe ſolitudes for ſeveral days together, during which time their families, their unhappy wives in particular, experience a ſtate of the moſt dreadful anxiety: they dare not go to reſt for fear of ſeeing their huſbands appear to them in a dream; for it is a received opinion in the country, that when a man has periſhed, either in the ſnow, or on ſome unknown rock, he appears by night to the perſon he held moſt dear, deſcribes the place that proved fatal to him, and requeſts the performance of the laſt duties to his corpſe.

“ After this picture of the life which the chamois hunters lead, could one imagine that this chaſe would be the object of a paſſion abſolutely unſurmountable? I knew a well made, handſome man, who had juſt married a beautiful woman:—‘ My grandfather, ſaid he to me, loſt his life in the chaſe; ſo did my father; and I am perſuaded that I too ſhall die in the ſame manner; this bag which I carry with me when I hunt I call my grave clothes; for I am ſure I will have no other; yet, if you ſhould offer to make my fortune on condition of abandoning the chaſe of the chamois, I could not conſent.’ I made ſome excurſions on the Alps with this man: His ſtrength and addreſs were aſtoniſhing; but his temerity was greater than his ſtrength; and I have heard, that two years afterwards, he miſſed a ſtep on the brink of a precipice, and met with the fate he had expected.

Voyages dans les Alpes, par M. Sauſſure, tom. iii.

“ The few who have grown old in this employment bear upon their faces the marks of the lives they have led. A ſavage look, ſomething in it haggard and wild, makes them be known in the midſt of a crowd, even when they are not in their hunting dreſs. And undoubtedly it is this ill look which makes ſome ſuperſtitious peaſants believe that they are ſorcerers, that they have dealings with the devil in their ſolitudes, and that it is he who throws them down the rocks. What then can be the paſſionate inducement to this courſe of life? It is not avarice, at leaſt it is not an avarice conſiſtent with reaſon: the moſt beautiful chamois is never worth more to the perſon that kills it than a dozen of francs, even including the value of its fleſh: and now that the number is ſo much diminiſhed, the time loſt before one can be taken is much more than its value. But it is the very dangers that attend the purſuit, thoſe alternations of hope and fear, the continual agitation and exerciſe which theſe emotions produce in the mind, that inſtigate the hunter: they animate him as they do the gameſter, the warrior, the ſailor, and even to a certain degree, the naturaliſt of the Alps; whoſe life, in ſome meaſure, pretty much reſembles that of the hunter, whoſe manners we have deſcribed."

But there is another kind of hunting, which is neither dangerous nor laborious, nor fatal to any one but to the poor animals that are the objects of it.—Theſe are the marmots, animals that inhabit the high mountains; where in ſummer they ſcoop out holes, which they line with hay, and retire to at the beginning of autumn. Here they grow torpid with the cold, and remain in a ſort of lethargy, till the warmth of the ſpring returns to quicken their languid blood, and to recal them to life. When it is ſuppoſed that they have retired to their winter abode, and before the ſnow has covered the high paſtures where their holes are made, people go to unharbour them. They are found from 10 to 13 in the ſame hole, heaped upon one another, and buried in the hay. Their ſleep is ſo profound, that the hunter often puts them into his bag, and carries them home without their awaking. The fleſh of the young is good, though it taſtes of oil, and ſmells ſomewhat of muſk; the fat is uſed in the cure of rheumatiſms and pains, being rubbed on the parts affected; but the ſkin is of little value, and is ſold for no more than five or ſix ſols. Notwithſtanding the little benefit they reap from it, the people of Chamouni go in queſt of this animal with great eagerneſs, and its numbers accordingly diminiſh very ſenſibly.

It has been ſaid, that marmots, in order to tranſport the hay into their holes, uſe one of their number laid on his back as a cart; but this is fabulous, for they are ſeen carrying the hay in their mouths. Nor is it for food that they gather it, but for a bed, and in order to ſhut out the cold, and to guard the avenues of their retreat from enemies. When they are taken in autumn, their bowels are quite empty, and even as clean as if they had been waſhed with water; which proves that their torpidity is preceded by a faſt, and even by an evacuation; a wiſe contrivance of nature for preventing their accumulated fæces from growing putrid or too dry, in the long lethargy they are expoſed to. They alſo continue a few days after their revival without eating, probably to allow the circulation and digeſtive power to recover their activity. At firſt, leaving their holes, they appear ſtupid and dazzled with the light; they are at this time killed with ſticks, as they do not endeavour to fly, and their bowels are then alſo quite empty. They are not very lean when they awake, but grow more ſo for a few days after they firſt come abroad. Their blood is never congealed, however profound their ſleep may be; for at the time that it is deepeſt, if they are bled, the blood flows as if they were awake.

In theſe countries the period is ſo ſhort between the diſſolution of the ſnow and its return, that grain has hardly time to come to maturity. Mr Sauſſure mentions a very uſeful and ingenious practice, invented by the mountaineers of the Argentiere, for enlarging this period, "I obſerved (ſays he) in the middle of the valley, ſeveral large ſpaces where the ſurface of the ſnow exhibited a ſingular appearance, ſomewhat reſembling a piece of white cloth ſpotted with black. While I was endeavouring to divine the cauſe of this phenomenon, I diſcovered ſeveral women walking with meaſured pace, and ſowing ſomething in handfuls that was black; and which being ſcattered, regularly diverging on the ſurface of the ſnow, formed that ſpotted appearance that I had been admiring. I could not conceive what ſeed ſhould be ſown on ſnow ſix feet deep; but my guide, aſtoniſhed at my ignorance, informed me that it was black earth ſpread upon the ſnow to accelerate its melting; and thus to anticipate, by a fortnight or three weeks, the time of labouring the fields and ſowing. I was ſtruck with the elegant ſimplicity of a practice ſo uſeful, the effects of which I already ſaw very evidently in places which had not been thus treated above three days.

"As to the inhabitants of Chamouni, the men, like thoſe of moſt high valleys, are neither well made nor tall; but they are nervous and ſtrong, as are alſo the women. They do not attain to a great age: men of 80 are very rare. Inflammatory diſeaſes are the moſt fatal to them; proceeding, no doubt, from obſtructed perſpiration, to which the inconſtant temperature of the climate expoſes them.

"They are in general honeſt, faithful, and diligent in the practice of religious duties. It would, for inſtance, be in vain to perſuade them to go anywhere on a holiday before hearing maſs. They are economical, but charitable. There are amongſt them neither hoſpitals nor foundations for the poor; but orphans and old people, who have no means of ſubſiſtence, are entertained by every inhabitant of a pariſh in his turn. If a man is prevented by age or infirmities from taking charge of his affairs, his neighbours join among themſelves and do it for him.

"Their mind is active and lively, their temper gay, with an inclination to raillery: they obſerve, with ſingular acuteneſs, the ridiculous in ſtrangers, and turn it into a fun of very facetious merriment among themſelves, yet they are capable of ſerious thinking: many of them have attacked me on religious and metaphyſical ſubjects: not as profeſſing a different faith from theirs, but on general queſtions, which ſhowed they had ideas independent of thoſe they were taught."

CHAMPAGNE, a conſiderable province of France, about 162 miles in length, and 112 in breadth, bounded on the north by Hainault and Luxembourg, on the eaſt by Lorrain and the Franche Compte, on the ſouth by Burgundy, and on the weſt by the Iſle of

France and Soiſſonnois. It has a great number of rivers, the principal of which are the Meuſe, the Seine, the Marne, the Aube, and the Aine. Its principal trade conſiſts in excellent wine, all ſorts of corn, linen cloth, woollen ſtuffs, cattle, and ſheep. It is alſo divided into the higher and lower; and Troyes is the capital town. Its ſubdiviſions are Champagne Proper, and Rhemois, the Retolois, the Pertois, the Village, Baſigni, the Senonois, and the Brie Champenois. It now forms the departments of Ardennes, Aube, Marne, and Upper Marne.

CHAMPAGNE *Proper*, is one of the eight parts of Champagne, which comprehends the town of Troyes, Chalons, St Menehould, Eperney, and Vertus.

CHAMPAIN, or *Point* CHAMPAIN, in *Heraldry*, a mark of diſhonour in the coat of arms of him who kills a priſoner of war after he has cried quarter.

CHAMPERTRY, in *Law*, a ſpecies of MAINTENANCE, and puniſhed in the ſame manner; being a bargain with the plaintiff or defendant *campum partire*, "to divide the land," or other matter ſued for, between them, if they prevail at law; whereupon the champertror is to carry on the party's ſuit at his own expence. This *champart*, in the French law, ſignifies a ſimilar diviſion of profits, being a part of the crop annually due to the landlord by bargain or cuſtom. In our ſenſe of the word, it ſignifies the purchaſing of a ſuit or right of ſuing; a practice ſo much abhorred by our law, that it is one main reaſon why a *choſe* in action, or thing of which one hath the right but not the poſſeſſion, is not aſſignable in common law; becauſe no man ſhould purchaſe any pretence to ſue in another's right. Theſe peſts of civil ſociety, that are perpetually endeavouring to diſturb the repoſe of their neighbours, and officiouſly interfering in other mens quarrels even at the hazard of their own fortunes, were ſeverely animadverted on by the Roman law, and were puniſhed by the forfeiture of a third part of their goods and perpetual infamy. Hitherto alſo muſt be referred the proviſion of the ſtatute 32 Henry VIII. c. 9. that no one ſhall ſell or purchaſe any pretended right or title to land, unleſs the vender hath received the profits thereof for one whole year before ſuch grant, or hath been in actual poſſeſſion of the land, or of the reverſion or remainder; on pain that both purchaſer and vender ſhall each forfeit the value of ſuch land to the king and the proſecutor.

CHAMPION, a perſon who undertakes a combat in the place or quarrel of another; and ſometimes the word is uſed for him who fights in his own cauſe.

It appears, that champions, in the juſt ſenſe of the word, were perſons who fought inſtead of thoſe that, by cuſtom, were obliged to accept the duel, but had a juſt excuſe for diſpenſing with it, as being too old, infirm, or being eccleſiaſtics, and the like. Such cauſes as could not be decided by the courſe of common law were often tried by ſingle combat; and he who had the good fortune to conquer, was always reputed to have juſtice on his ſide. See the article BATTLE.

CHAMPION *of the king* (*campio regis*), is an ancient officer, whoſe office is, at the coronation of our kings, when the king is at dinner, to ride armed *cap-a-pee*, into Weſtminſter-hall, and by the proclamation of a herald make a challenge, "That if any man ſhall deny the king's title to the crown, he is there ready to defend it in ſingle combat, &c." which being done, the king drinks to him, and ſends him a gilt cup with a cover full of wine, which the champion drinks, and hath the cup for his fee. This office at the coronation of King Richard II. when Baldwin Ferville exhibited his petition for it, was adjudged from him to his competitor Sir John Dymocke, (both claiming from Marmion), and hath continued ever ſince in the family of the Dymockes; who hold the manor of Sinvelſby in Lincolnſhire, hereditary from the Marmions by grand ſerjeantry, viz. that the lord thereof ſhall be the king's champion as aforeſaid. Accordingly Sir Edward Dymocke performed this office at the coronation of King Charles II.; a perſon of the name of Dymocke performed at the coronation of his preſent majeſty George III.

CHAMPLAIN, SAMUEL DE, a celebrated French navigator, the founder of the colony of New France, or Canada. He built Quebec; and was the firſt governor of the colony in 1603. Died after 1649. See QUEBEC.

CHANANÆI, in *Ancient Geography*, the name of the ancient inhabitants of Canaan in general, deſcendants of Canaan; but peculiarly appropriated to ſome one branch; though uncertain which branch or ſon of Canaan it was, or how it happened that they preferred the common gentilitious name to one more appropriated as deſcendants of one of the ſons of Canaan; unleſs from their courſe of life, as being in the mercantile way, the import of the name of *Canaan*; and for which their ſituation was greatly adapted, they living on the ſea and about Jordan, and thus occupying the greater part of the Land of Promiſe.

CHANCE, a term we apply to events, to denote that they happen without any neceſſary or foreknown cauſe. See CAUSE.

Our aim is, to aſcribe thoſe things to *chance* which are not neceſſarily produced as the natural effects of any proper cauſe: but our ignorance and precipitancy lead us to attribute effects to *chance* which have a neceſſary and determinate cauſe.

When we ſay a thing happens *by chance*, we really mean no more than that its cauſe is unknown to us: not, as ſome vainly imagine, that *chance* itſelf can be the cauſe of any thing.

The caſe of the painter, who unable to expreſs the foam at the mouth of a horſe he had painted, threw his ſponge in deſpair at the piece, and *by chance*, did that which he could not before do by deſign, is an eminent inſtance of the force of *chance*: yet, it is obvious, all we mean here by *chance*, is, that the painter was not aware of the effect; or that he did not throw the ſponge with ſuch a view: not but that he actually did every thing neceſſary to produce the effect; inſomuch, that conſidering the direction wherein he threw his ſponge, together with its form, ſpecific gravity, the colours wherewith it was ſmeared, and the diſtance of the hand from the piece, it was impoſſible, on the preſent ſyſtem of things, the effect ſhould not follow.

Chance is frequently perſonified, and erected into a chimerical being, whom we conceive as acting arbitrarily, and producing all the effects whoſe real cauſes do not appear to us; in which ſenſe the word coincides with the τυχη, *fortuna*, of the ancients.

CHANCE is alſo uſed for the manner of deciding things, the conduct or direction whereof is left at large, and not reducible to any determinate rules or meaſures, or where there is no ground for preference: as at cards, dice, lotteries, &c.

For the laws of CHANCE, *or the Proportion of Hazard in Gaming*, ſee GAME.

The ancient *ſortilege*, or *chance*, Mr Placette obſerves, was inſtituted by God himſelf: and in the Old Teſtament we find ſeveral ſtanding laws and expreſs commands which preſcribed its uſe on certain occaſions. Hence the Scripture ſays, "The *lot* or *chance*, fell on Matthias," when it was in queſtion who ſhould fill Judas's place in the apoſtolate.

Hence alſo aroſe the *ſortes ſanctorum*, or method of determining things, among the ancient Chriſtians, by opening ſome of the ſacred books, and pitching on the firſt verſe they caſt their eye on, as a ſure prognoſtic of what was to befal them. The *ſortes Homericæ*, *Virgilianæ*, *Præneſtinæ*, &c. uſed by the heathens, were with the ſame view, and in the ſame manner. See SORTES.

St Auguſtine ſeems to approve of this method of determining things future, and owns that he had practiſed it himſelf; grounded on this ſuppoſition, that God preſides over *chance*; and on Prov. xvi. 33.

Many among the modern divines hold *chance* to be conducted in a particular manner by Providence; and eſteem it an extraordinary way which God uſes to declare his will, and a kind of immediate revelation.

CHANCE-*Medley*, in *Law*, is where one is doing a lawful act, and a perſon is killed by chance thereby; for if the act be unlawful, it is felony. If a perſon caſt, not intending harm, a ſtone, which happens to hit one, whereof he dies; or ſhoots an arrow in a highway, and another that paſſeth by is killed therewith; or if a workman, in throwing down rubbiſh from a houſe after warning to take care, kills a perſon; or a ſchoolmaſter in correcting his ſcholar, a maſter his ſervant, or an officer in whipping a criminal in a reaſonable manner, happens to occaſion his death; it is chance-medley and miſadventure. But if a man throw ſtones in a highway where perſons uſually paſs; or ſhoot an arrow, &c. in a market-place among a great many people; or if a workman caſt down rubbiſh from a houſe in cities and towns where people are continually paſſing; or a ſchoolmaſter, &c. correct his ſervant or ſcholar, &c. exceeding the bounds of moderation; it is manſlaughter: and if with an improper inſtrument of correction, as with a ſword or iron bar, or by kicking, ſtamping, &c. in a cruel manner, it is murder. If a man whips his horſe in a ſtreet to make him gallop, and the horſe runs over a child and kills it, it is manſlaughter: but if another whips the horſe, it is manſlaughter in him, and chance-medley in the rider. And if two are fighting, and a third perſon coming to part them is killed by one of them without any evil intent, yet this is murder in him, and not manſlaughter by chance-medley or miſadventure. In chance-medley, the offender forfeits his goods; but hath a pardon of courſe.

CHANCEL, is properly that part of the choir of a church, between the altar or communion-table and the baluſtrade or rail that encloſes it, where the miniſter is placed at the celebration of the communion. The word comes from the Latin *cancellus*, which in the lower Latin is uſed in the ſame ſenſe, from *cancelli*, "lattices or croſs bars, wherewith the chancels were anciently encompaſſed, as they now are with rails. The right of a ſeat and a ſepulchre in the chancels is one of the privileges of founders.

CHANCELLOR, was at firſt only a chief notary or ſcribe under the emperors; and was called *cancellarius*, becauſe he ſat behind a lattice (in Latin *cancellus*), to avoid being crowded by the people: though ſome derive the word from *cancellare*, "to cancel." (See CHANCERY.) This officer was afterwards inveſted with ſeveral judicial powers, and a general ſuperintendency over the reſt of the officers of the prince. From the Roman empire it paſſed to the Roman church, ever emulous of imperial ſtate: and hence every biſhop has to this day his chancellor, the principal judge of his conſiſtory. And when the modern kingdoms of Europe were eſtabliſhed upon the ruins of the empire, almoſt every ſtate preſerved its chancellor with different juriſdictions and dignities, according to their different conſtitutions. But in all of them he ſeems to have had the ſupervision of all charters, letters, and ſuch other public inſtruments of the crown as were authenticated in the moſt ſolemn manner: and therefore, when ſeals came in uſe, he had always the cuſtody of the king's great ſeal.

Lord High CHANCELLOR *of Great Britain*, or *Lord Keeper of the Great Seal*, is the higheſt honour of the long robe, being created by the mere delivery of the king's great ſeal into his cuſtody: whereby he becomes, without writ or patent, an officer of the greateſt weight and power of any now ſubſiſting in the kingdom. He is a privy counſellor by his office; and, according to Lord Chancellor Elleſmere, prolocutor of the houſe of lords by preſcription. To him belongs the appointment of all the juſtices of the peace throughout the kingdom. Being in former times commonly an eccleſiaſtic (for none elſe were then capable of an office ſo converſant in writing), and preſiding over the royal chapel, he became keeper of the king's conſcience; viſitor, in right of the king, of all hoſpitals and colleges of the king's foundation; and patron of all the king's livings under the value of 20l. per annum in the king's books. He is the general guardian of all infants, idiots, and lunatics; and has the general ſuperintendence of all charitable uſes in the kingdom; and all this over and above the vaſt extenſive juriſdiction which he exerciſes in his judicial capacity in the court of chancery. He takes a precedence of every temporal lord except the royal family, and of all others except the archbiſhop of Canterbury. See CHANCERY.

CHANCELLOR, in Scotland, was the chief in matters of juſtice. In the laws of King Malcolm II. he is placed before all other officers; and from theſe it appears that he had the principal direction of the chancery, or chancellary as it is called, which is his proper office. He had the cuſtody of the king's ſeal; and he was the king's moſt intimate counſellor, as appears by an old law cited by Sir James Balfour: "The

chancellar

Chancellor.

chancellar ſal at al tymes aſſiſt the king, in giving him counſall mhir ſecretly nor the reſt of the nobility, to quhais ordinances all officiaris, als well of the realme as of the kingis hous, ſould anſwer and obey. The chancellar ſal be ludgit neir unto the kingis grace, for keiping of his bodie, and the ſeill; and that he may be readie baith day and nicht at the kingis command." By having the cuſtody of the great ſeal, he had an opportunity of examining the king's grants, and other deeds which were to paſs under it, and to cancel them if they appeared againſt law, and were obtained ſurreptitiouſly or by falſe ſuggeſtions.

King James VI. ordained the chancellor to have the firſt place and rank in the nation, *ratione officii*; by virtue whereof he preſided in the parliament, and in all courts of judicature. After the reſtoration of King Charles II. by a particular declaratory law, parliament firſt, the lord chancellor was declared, by virtue and right of his office, preſident, in all the meetings of parliament, or other public judicatures of the kingdom. Although this act was made to declare the chancellor preſident of the exchequer as well as other courts, yet in 1663 the king declared the treaſurer to be preſident of that court.

The office of lord chancellor was aboliſhed by the Union, there being no farther uſe for the judicial part of this office; and to anſwer all the other parts of the chancellor's office, a lord keeper of the great ſeal was erected, with a ſalary of 3000l. a-year.

Chancellor of a cathedral, an officer that hears leſſons and lectures read in the church, either by himſelf or his vicar; to correct and ſet right the reader when he reads amiſs; to inſpect ſchools; to hear cauſes; apply the ſeal; write and diſpatch the letters of the chapter; keep the books; take care that there be frequent preachings, both in the church and out of it; and aſſign the office of preaching to whom he pleaſes.

Chancellor of the Duchy of Lancaſter, an officer appointed chiefly to determine controverſies between the king and his tenants of the duchy land, and otherwiſe to direct all the king's affairs belonging to that court. See *Duchy Court*.

Chancellor of the Exchequer, an officer who preſides in that court, and takes care of the intereſt of the crown. He is always in commiſſion with the lord-treaſurer, for the letting of crown lands, &c. and has power with others, to compound for forfeitures of lands upon penal ſtatutes. He has alſo great authority in managing the royal revenues, and in matters relating to the firſt fruits.

Chancellor of the order of the Garter and other Military Orders, is an officer who ſeals the commiſſions and mandates of the chapter and aſſembly of the knights, keeps the regiſter of their proceedings, and delivers acts thereof under the ſeal of their order.

Chancellor of an Univerſity, is he who ſeals the diplomas, or letters of degrees, proviſion, &c. given in the univerſity.

The chancellor of Oxford is uſually one of the prime nobility, choſen by the ſtudents themſelves in convocation. He is their chief magiſtrate; his office is, *durante vita*, to govern the univerſity, preſerve and defend its rights and privileges, convoke aſſemblies, and do juſtice among the members under this juriſdiction.

Chancellor's Court || Chancery.

Under the chancellor is the vice chancellor, who is choſen annually, being nominated by the chancellor, and elected by the univerſity in convocation. He is always the head of ſome college, and in holy orders. His proper office is to execute the chancellor's power, to govern the univerſity according to her ſtatutes, to ſee that officers and ſtudents do their duty, that courts be duly called, &c. When he enters upon his office, he chooſes four pro-vice chancellors out of the heads of the colleges, to execute his power in his abſence.

The chancellor of Cambridge is alſo uſually one of the prime nobility, and in moſt reſpects the ſame as that in Oxford: only he does not hold his office *durante vita*, but may be elected every three years. Under the chancellor there is a commiſſary, who holds a court of record for all privileged perſons and ſcholars under the degree of maſter of arts, where all cauſes are tried and determined by the civil and ſtatute law, and by the cuſtom of the univerſity.

The vice chancellor of Cambridge is choſen annually by the ſenate, out of two perſons nominated by the heads of the ſeveral colleges and halls.

Chancellor's Court. See *Univerſity, Courts*.

CHANCERON, in *Natural Hiſtory*, a name given by the French writers to the ſmall caterpillar, that eats the corn, and does vaſt miſchief in their granaries. See the article *Corn-Butterfly*.

CHANCERY, the higheſt court of juſtice in Britain next to the parliament, and of very ancient inſtitution. It has its name chancery (*cancellaria*) from the judge who preſides here, the lord chancellor, or *cancellarius*; who according to Sir Edward Coke, is ſo termed, *à cancellando*, from cancelling the king's letters patent when granted contrary to law, which is the higheſt point of his juriſdiction. In chancery there are two diſtinct tribunals: the one ordinary, being a court of common law; the other extraordinary, being a court of equity.

Blackſt. Comment.

1. The *ordinary* legal court holds pleas of recognizances acknowledged in the chancery, writs of *ſcire facias*, for repeal of letters patent, writs of partition, &c. and alſo of all perſonal actions by or againſt any officer of the court. Sometimes a *ſuperſedeas*, or writ of privilege, hath been here granted to diſcharge a perſon out of priſon: one from hence may have a *habeas corpus* prohibition, &c. in the vacation; and here a *ſubpœna* may be had to force witneſſes to appear in other courts, when they have no power to call them. But, in proſecuting cauſes, if the parties deſcend to iſſue, this court cannot try it by jury; but the lord-chancellor delivers the record into the king's bench to be tried there; and after trial had, it is to be remanded into the chancery, and there judgment given; though if there be a demurer in law, it ſhall be argued in this court.

In this court is alſo kept the *officina juſtitiæ*; out of which all original writs that paſs under the great ſeal, all commiſſions of charitable uſes, ſewers, bankruptcy, idiocy, lunacy, and the like, do iſſue; and for which it is always open to the ſubject, who may there at any time demand and have, *ex debito juſtitiæ*, any writ that his occaſions may call for. Theſe writs, relating to the buſineſs of the ſubject, and the returns of them, were, according to the ſimplicty of ancient times. originally kept in a hamper, *in banaſerio*; and the others (relating to ſuch matters wherein the crown is mediately or immediately concerned) were preſerved in a little ſack or bag, *in parva baga*; and hence hath ariſen the diſtinction of the *banaper* office, and the *petty bag* office, which both belong to the common law court in chancery.

2. The *extraordinary* court, or court of equity, proceeds by the rules of equity and conſcience, and moderates the rigour of the common law, conſidering the *intention* rather than the *words* of the law. It gives relief for and againſt infants notwithſtanding their minority, and for or againſt married women notwithſtanding their coverture. All frauds and deceits for which their is no redreſs at common law; all breaches of truſt and confidence; and accidents, as to relieve obligors, mortgagers, &c. againſt penalties and forfeitures, where the intent was to pay the debt, are here remedied: for in chancery, a forfeiture, &c. ſhall not bind, where a thing may be done after, or compenſation made for it. Alſo this court will give relief againſt the extremity of unreaſonable engagements entered into without conſideration; oblige creditors that are unreaſonable to compound with an unfortunate debtor; and make executors, &c. give ſecurity and pay intereſt for money that is to lie long in their hands. This court may confirm title to lands, though one hath loſt his writings; and render conveyances defective through miſtake, &c. good and perfect. In chancery, copy-holders may be relieved againſt the ill uſage of their lords; encloſures of lands that are common be decreed; and this court may decree money or lands given to charitable uſes, oblige men to account with each other, &c. But in all caſes where the plaintiff can have his remedy at law, he ought not to be relieved in chancery; and a thing which may be tried by a jury is not triable in this court.

The proceedings in chancery are, firſt to file the bill of complaint, ſigned by ſome counſel, ſetting forth the fraud or injury done, or wrong ſuſtained, and praying relief: after the bill is filed, proceſs of *ſubpœna* iſſues to compel the defendant to appear; and when the defendant appears, he puts in his anſwer to the bill of complaint, if there be no cauſe for the plea to the juriſdiction of the court, in diſability of the perſon, or in bar, &c. Then the plaintiff brings his replication, unleſs he files exceptions againſt the anſwer as inſufficient, referring it to a maſter to report whether it be ſufficient or not; to which report exceptions may alſo be made. The anſwer, replication, rejoinder, &c. being ſettled, and the parties come to iſſue, witneſſes are to be examined upon interrogatories, either in court or by commiſſion in the country, wherein the parties uſually join; and when the plaintiff and defendant have examined their witneſſes, publication is to be made of the depoſitions, and the cauſe is to be ſet down for hearing; after which follows the decree. But it is now uſual to appeal to the houſe of lords; which appeals are to be ſigned by two noted counſel, and exhibited by way of petition; the petition or appeal is lodged with the clerk of the houſe of lords, and read in the houſe, whereon the appellee is ordered to put in his anſwer, and a day fixed for hearing the cauſe; and after counſel heard, and evidence given on both ſides, the lords will affirm or reverſe the decree of the chancery, and finally determine the cauſe by a majority of votes, &c.

CHANDELIER, in fortification, a kind of moveable parapet, conſiſting of a wooden frame, made of two upright ſtakes, about ſix feet high, with croſs planks between them; ſerving to ſupport faſcines to cover the pioneers.

CHANDERNAGORE, a French ſettlement in the kingdom of Bengal in the Eaſt Indies. It lies on the river Ganges, two leagues and a half above Calcutta. The diſtrict is hardly a league in circumference, and has the diſadvantage of being ſomewhat expoſed on the weſtern ſide; but its harbour is excellent, and the air is as pure as it can be on the banks of the Ganges. Whenever any building is undertaken that requires ſtrength, it muſt here, as well as in all other parts of Bengal, be built upon piles, it being impoſſible to dig three or four feet without coming at water.

CHANDLER, Mary, diſtinguiſhed by her talent for poetry, was the daughter of a diſſenting miniſter at Bath, and was born at Malmſbury in Wiltſhire in 1687. She was bred a milliner; but from her childhood had a turn for poetry, and in her riper years applied herſelf to the ſtudy of the poets. Her poems for which ſhe was complimented by Mr Pope, breathe the ſpirit of piety and philoſophy. She had the miſfortune to be deformed, which determined her to live ſingle; though ſhe had great ſweetneſs of countenance, and was ſolicited to marry. She died in 1745, aged 58.

Chandler, *Dr Samuel*, a learned and reſpectable diſſenting miniſter, deſcended from anceſtors who had heartily engaged in the cauſe of religious liberty, and ſuffered for the ſake of conſcience and nonconformity; was born at Hungerford in Berks, where his father was a miniſter of conſiderable worth and abilities. Being by his literary turn deſtined to the miniſtry, he was firſt placed at an academy at Bridgewater, and from thence removed to Glouceſter under Mr Samuel Jones. Among the pupils of Mr Jones were Mr Joſeph Butler, afterwards biſhop of Durham, and Mr Thomas Secker, afterwards archbiſhop of Canterbury. With theſe eminent perſons he contracted a friendſhip that continued to the end of their lives, notwithſtanding the different views by which their conduct was afterwards directed, and the different ſituations in which they were placed.

Mr Chandler having finiſhed his academical ſtudies, began to preach about July 1714; and being ſoon diſtinguiſhed by his talents in the pulpit, he was choſen in 1716 miniſter of the Preſbyterian congregation at Peckham near London, in which ſtation he continued ſome years. Here he entered into the matrimonial ſtate, and began to have an increaſing family, when, by the fatal South Sea ſcheme of 1720, he unfortunately loſt the whole fortune which he had received with his wife. His circumſtances being thereby embarraſſed, and his income as a miniſter being inadequate to his expences, he engaged in the trade of a bookſeller, and kept a ſhop in the Poultry, London, for about two or three years, ſtill continuing to diſcharge the duties of the paſtoral office. He alſo officiated as joint preacher with the learned Dr Lardner of a winter weekly evening lecture at the meeting houſe in the Old Jewry, London: in which meeting he was eſtabliſhed aſſiſtant preacher about the year 1725, and then as the paſtor. Here he adminiſtered to the religious improvement of a very reſpectable congregation for 40 years with the greateſt applauſe; and with what diligence and application he improved the vacancies of time from his paſtoral duties, for improving himſelf and benefiting the world, will appear from his many writings on a variety of important ſubjects. While he was thus laudably employed, not only the univerſities of Edinburgh and Aberdeen gave him, without any application, teſtimonies of their eſteem in diplomas, conferring on him the degree of D. D. but he alſo received offers of preferment from ſome of the governors of the eſtabliſhed church, which he nobly declined. He had likewiſe the honour of being afterwards elected F. R. and A. SS.

On the death of George II. in 1760, Dr Chandler publiſhed a ſermon on that event, in which he compared that prince to King David. This gave riſe to a pamphlet, which was printed in the year 1761, entitled "The Hiſtory of the Man after God's own Heart;" wherein the author ventured to exhibit King David as an example of perfidy, luſt, and cruelty, fit only to be ranked with a Nero or a Caligula; and complained of the inſult that had been offered to the memory of the late Britiſh monarch by Dr Chandler's parallel between him and the king of Iſrael. This attack occaſioned Dr Chandler to publiſh in the following year "A Review of the Hiſtory of the Man after God's own Heart; in which the Falſehoods and Miſrepreſentations of the Hiſtorian are expoſed and corrected." He alſo prepared for the preſs a more elaborate work, which was afterwards publiſhed in two volumes 8vo, under the following title: "A Critical Hiſtory of the Life of David; in which the principal Events are ranged in Order of time; the chief Objections of Mr Bayle and others againſt the Character of this Prince, the Scripture Account of him, and the Occurrences of his Reign, are examined and refuted; and the Pſalms which refer to him explained. As this was the laſt, it was likewiſe one of the beſt, of Dr Chandler's productions. The greateſt part of this work was printed off at the time of our author's death, which happened May 8. 1766, aged 73. During the laſt year of his life, he was viſited with frequent returns of a very painful diſorder, which he endured with great reſignation and Chriſtian fortitude. He was interred in the burying-ground at Bunhill-fields on the 16th of the month; and his funeral was very honourably attended by miniſters and other gentlemen. He expreſsly deſired, by his laſt will, that no delineation of his character might be given in his funeral ſermon, which was preached by Dr Amory. He had ſeveral children; two ſons and a daughter who died before him, and three daughters who ſurvived him; two of whom are yet living, and both married, one of them to the Rev. Dr Harwood.

Dr Chandler was a man of very extenſive learning and eminent abilities; his apprehenſion was quick and his judgment penetrating; he had a warm and vigorous imagination; he was a very inſtructive and animated preacher; and his talents in the pulpit and as a writer procured him very great and general eſteem, not only among the diſſenters, but among large numbers of the eſtabliſhed church. He was principally inſtrumental in the eſtabliſhment of the fund for relieving the widows and orphans of poor Proteſtant diſſenting miniſters: the plan of it was firſt formed by him; and it was by his intereſt and application to his friends that many of the ſubſcriptions for its ſupport were procured.

In 1768, four volumes of our author's ſermons were publiſhed by Dr Amory, according to his own directions in his laſt will; to which were prefixed a neat engraving of him, from an excellent portrait by Mr Chamberlin. He alſo expreſſed a deſire to have ſome of his principal pieces reprinted in four volumes 8vo: propoſals were accordingly publiſhed for that purpoſe, but did not meet with ſufficient encouragement. But in 1777, another work of our author was publiſhed in one volume 4to, under the following title: "A Paraphraſe and notes on the Epiſtles of St Paul to the Galatians and Epheſians, with doctrinal and practical Obſervations: together with a critical and practical Commentary on the two Epiſtles of St Paul to the Theſſalonians." Dr Chandler alſo left, in his interleaved Bible, a large number of critical notes, chiefly in Latin, which are now the property of Dr Kippis, Mr Farmer, Dr Price, and Dr Savage, and which have been intended to be publiſhed; but the deſign has not yet been executed. A complete liſt of Dr Chandler's works is given in the Biographia Britannica, vol. iii. p. 435.

CHANG-TONG, a province of China, bounded on the eaſt by Petcheli and part of Honan, on the ſouth by Kiang-nan, on the eaſt by the ſea, and on the north by the ſea and part of Petcheli. The country is well watered by lakes, ſtreams, and rivers; but is nevertheleſs liable to ſuffer from drought, as rain falls here but ſeldom. The locuſts alſo ſometimes make great devaſtation. However, it abounds greatly in game; and there is perhaps no country where quails, partridges, and pheaſants, are ſold cheaper, the inhabitants of this province being reckoned the keeneſt ſportſmen in the empire. This province is greatly enriched by the river Yun, called the *Grand Imperial Canal*, through which all the barks bound to Pekin muſt paſs in their way thither. The duties on this canal alone amount to more than 450,000l. annually. The canal itſelf is greatly admired by European travellers on accout of its ſtrong and long dikes, the banks decorated with cut ſtone, the ingenious mechaniſm of its locks, and the great number of natural obſtacles which have been overcome in the execution of the work. The province produces ſilk of the ordinary kind; and beſides this, another from a ſort of inſect reſembling our caterpillar. It is coarſer than the ordinary ſilk, but much ſtronger and more durable; ſo that the ſtuffs made from it have a very extenſive ſale throughout the empire.

Chang-tong is remarkable for being the birthplace of the celebrated philoſopher and law-giver Confucius. His native city is called *Kio-feou*, where there are ſeveral monuments erected in honour of this great man. The province is divided into ſix diſtricts, which contain ſix cities of the firſt claſs, and 114 of the ſecond and third. Along the coaſt, alſo, are 15 or 16 villages of conſiderable importance on account of their commerce; there is likewiſe a number of ſmall iſlands, moſt of which have harbours very convenient for the Chineſe junks which paſs from thence to Corea or Leatong. The moſt remarkable cities are, 1. Tſi-nan-fou, the

the capital, which ſtands ſouth of the river Tſing-ho or Tſi. It is large and populous; but chiefly celebrated for having been the reſidence of a long ſeries of kings, whoſe tombs, riſing on the neighbouring mountains, afford a beautiful proſpect. 2. Yen tcheu-fou, the ſecond city of the province, ſituated between two rivers and in a mild and temperate climate. Great quantities of gold are ſaid to have been formerly collected in its neighbourhood. 3. Lin-tçin-tcheu, ſituated on the great canal, is much frequented by ſhips, and may be called a general magazine for every kind of merchandiſe. Here is an octagonal tower, divided into eight ſtories, the walls of which are covered on the outſide with porcelain loaded with various figures neatly executed, and incruſted on the inſide with variouſly coloured marble. A ſtaircaſe, conſtructed in the wall, conducts to all the ſtories, from which there are paſſages that lead into magnificent galleries ornamented with gilt balluſtrades. All the cornices and projections of the tower are furniſhed with little bells; which, ſays M. Groſier, when agitated by the wind, form a very agreeable harmony. In the higheſt ſtory is an idol of gilt copper, to which the tower is dedicated. In the neighbourhood are ſome other temples, the architecture of which is exceedingly beautiful.

CHANGER, an officer belonging to the king's mint, who changes money for gold or ſilver bullion. See Mint.

Money-Changer, is a banker, who deals in the exchange, receipt, and payment of moneys. See Banker.

CHANGES, in *Arithmetic*, &c. the permutations or variations of any number of quantities; with regard to their poſition, order, &c. See Combination.

To find all the poſſible Changes of any number of Quantities, or how oft their Order may be varied.] Suppoſe two quantities *a* and *b*. Since they may be either wrote *a b* or *b a*, it is evident their *changes* are $2=2.1$. Suppoſe three quantities *a b c*: their *changes* will be as in the margin; as is evident by combining *c* firſt with *a b*, then with *b a*; and hence the number of *changes* ariſes $3.\ 2.\ 1=6$. If the quantities be 4, each may be combined four ways with each order of the other three; whence the number of changes ariſes $6.\ 4.=4.\ 3.\ 2.\ 1.=24$. Wherefore, if the number of quantities be ſuppoſed *n*, the number of *changes* will be $n.n-1.n-2.n-3.n-4$. &c.

c a b
a c b
a b c
———
c b a
b c a
b a c

If the ſame quantity occur twice, the *changes* of two will be found *b b*; of three, *b a b*, *a b b*, *b b c*; of four, *c b a b*, *b c a b*, *b a b c*. And thus the number of *changes* in the firſt caſe will be $1=(2.\ 1):2.\ 1$; in the ſecond, $3=(3.\ 2.\ 1):2.\ 1$: in the third, $12=(4.\ 3.\ 2.\ 1):2.\ 1$.

If a fifth letter be added, in each ſeries of four quantities it will beget five *changes*, whence the number of all the *changes* will be $60=(5.\ 4.\ 3.\ 2.)\ 1,:2.\ 1$. Hence if the number of quantities be *n*, the number of *changes* will be $(n.n-1.n-2.n-3.n-4$ &c.$):2.\ 2$. From theſe ſpecial formulæ may be collected a general one, viz. if *n* be the number of quantities, and *m* the number which ſhows how oft the ſame quantity occurs; we ſhall have $(n.n-1.n-2.n-3.n-4.n-5.n-6.n-7.n-8.n-9$. &c.$):(m.m-1.m-2.m-3.m-4$. &c.$)$ the ſeries being to be continued, till the continual ſubtraction of unity from *n* and *m* leave 0. After the ſame manner we may proceed further, till putting *n* for the number of quantities, and *l*, *m*, *r*, &c. for the number that ſhows how oft any of them is repeated, we arrive at an univerſal form. $(n.n-1.n-2.n-3.n-4.n-5.n-6.n-7.n-8$. &c.$):(l.l-1.l-2.l-3.l-4.l-5$. &c. $m.m-1.m-2.m-3$. &c. $r.r-1.r-2.r-3.r-4.r-5$. &c.$)$

Suppoſe, for inſtance, $n=6, l=3, r=0$. The number of *changes* will be $(6.\ 5.\ 4.\ 3.\ 2.\ 1.):(3.\ 2.\ 1.\ 3.\ 2.\ 1.)=(6.\ 5.\ 4.):(3.\ 2=2.\ 5.\ 2=20)$.

Hence, ſuppoſe thirteen perſons at a table, if it be required how oft they may *change* places; we ſhall find the number $13.\ 12.\ 11.\ 10.\ 9.\ 8.\ 7.\ 6.\ 5.\ 4.\ 3.\ 2.\ 1.=6227020800$.

In this manner may all the poſſible anagrams of any word be found in all languages, and that without any ſtudy: ſuppoſe, v. g. it were required to find the anagrams of the word *amor*, the number of *changes* will be

a
———
ma
am
———
oma
moa
mao

oam
aom
amo
———
roma
orma
omra
omar

rmoa
mroa
mora
moar
———
rmao
mrao

maro
maor
———
raom
oram
oarm
oamr
———
raom

arom
aorm
aomr
———
ramo
armo
amro
amor

The anagrams therefore of the word *amor*, in the Latin tongue, are *roma*, *mora*, *maro*, *ramo*, *armo*. See Anagram.

Whether this new method of anagramatizing be like to prove of much ſervice to that art, is left to the poets.

CHANNA, in *Zoology*, the name of a fiſh caught in great plenty in the Mediterranean, and brought to market in Italy and elſewhere, among the ſea perch, which it ſo nearly reſembles, that it would not be diſtinguiſhable from it, but that the ſea perch is bigger, and has only broad tranſverſe lines on its back, whereas the channa has them both tranſverſe and longitudinal. It has a very wide mouth, and its lower jaw is longer than its upper; ſo that its mouth naturally falls open. Its eyes are ſmall, and its teeth very ſharp: its back is of a blackiſh red: it has ſeveral longitudinal lines of a reddiſh hue; and its tail is marked with reddiſh ſpots. There is an obſervation, that in all the fiſh of this kind which have been examined by naturaliſts, there have been found none but females. This is as old as the days of Ariſtotle. Whether this be true in fact, would require many obſervations. If it ſhould prove ſo, the whole ſeems to end in this, that the channa is no diſtinct ſpecies, but only the female of ſome other fiſh. There is another fiſh not unlike this, called *cannadella*, or rather *channadella*, which at Marſeilles is known by the name of *chorina*.

CHANNEL, in *Geography*, an arm of the ſea, or a narrow ſea between two continents; or between a continent and an iſland. Such are the Britiſh channel, St George's channel, the channel of Conſtantinople, &c.

Channel of a ſhip. See *Chain-Wales.*

CHAN-SI, a province of China, and one of the ſmalleſt in the empire, is bounded on the eaſt by Petcheli, on the ſouth by Honan, on the weſt by Chen-ſi, and on the north by the great wall. The climate is healthful and agreeable, and the ſoil generally fertile, though the country is full of mountains. Some of theſe laſt are rough, wild, and uninhabited; but others are cultivated with the greateſt care from top to bottom, and cut into terraces, forming a very agreeable proſpect; while ſome have on their tops vaſt plains no leſs fertile than the richeſt low lands. Theſe mountains abound with coal, which the inhabitants pound and make into cakes with water; a kind of fuel which, though not very inflammable, affords a ſtrong and laſting fire when once kindled. It is principally uſed for heating their ſtoves, which are conſtructed with brick as in Germany; but the inhabitants of this province give them the form of ſmall beds, and ſleep upon them. The beſt grapes to be met with in this part of Aſia grow in the province of Chan-ſi; ſo that good wine might be made, but the people chooſe rather to dry and ſell them to the neighbouring provinces. The country abounds with muſk, porphyry, marble, lapis lazuli, and jaſper of various colours; and iron mines, as well as ſalt pits and cryſtal, are very common. Here are five cities of the firſt claſs, and eighty-five of the ſecond and third: the moſt remarkable are, 1. Tai-youen-fou the capital, an ancient city about three leagues in circumference, but much decayed in conſequence of being no longer the reſidence of the princes of the blood as it was formerly. Nothing now remains of the palaces of thoſe princes but a few ruins; but their tombs are ſtill to be ſeen on a neighbouring mountain. The burying place is magnificently ornamented; and all the tombs are of marble or cut ſtone, having near them triumphal arches, ſtatues of heroes, figures of lions and different animals, eſpecially horſes, and which are diſpoſed in very elegant order. An awful and melancholy gloom is preſerved around theſe tombs by groves of aged cypreſſes, which have never felt the ſtroke of the axe, placed chequer-wiſe. The principal articles of trade here are, hardware, ſtuffs of different kinds, particularly carpets in imitation of thoſe of Turkey. 2. Ngar-y is ſituated near a lake as ſalt as the ocean, from which a great quantity of ſalt is extracted. 3. Fuen-tcheou-fou, an ancient and commercial city built on the banks of the river Fuen-ho: it has baths and ſprings almoſt boiling hot, which, by drawing hither a great number of ſtrangers, add greatly to its opulence. 4. Tai-tong-fou, ſituated near the wall, is a place of great ſtrength, and important by reaſon of its ſituation, as being the only one expoſed to the incurſions of the Tartars. Its territories abound with lapis lazuli, medicinal herbs, and a particular kind of jaſper called *yieche*, which is as white and beautiful as agate; marble and porphyry are alſo common; and a great revenue is produced from the ſkins which are dreſſed here.

CHANT, (*cantus*), is uſed for the vocal muſic of churches.

In church hiſtory we meet with divers kinds of *chant* or *ſong*. The firſt is the *Ambroſian*, eſtabliſhed by St Ambroſe. The ſecond, the *Gregorian chant*, introduced by Pope Gregory the Great, who eſtabliſhed ſchools of chantors, and corrected the church-ſong. This is ſtill retained in the church under the name of *plain ſong*: at firſt it was called the *Roman ſong*. The *plain* or *Gregorian chant*, is where the choir and people ſing in uniſon, or all together in the ſame manner.

CHANTILLY, a village in France, about ſeven leagues from Paris, where there is a magnificent palace and fine foreſt formerly belonging to the duke of Bourbon.

CHANTOR, a ſinger of a choir in a cathedral. The word is almoſt grown obſolete, *choriſter* or *ſinging-man* being commonly uſed inſtead of it. All great chapters have chantors and chaplains to aſſiſt the canons, and officiate in their abſence.

Chantor is uſed by way of excellence for the precentor or maſter of the choir, which is one of the firſt dignities of the chapter. At St David's in Wales, where there is no dean, he is next in dignity to the biſhop. The ancients called the chantor *primicerius cantorum*. To him belonged the direction of the deacons and other inferior officers.

Chantors, in the temple of Jeruſalem, were a number of Levites employed in ſinging the praiſes of God, and playing upon inſtruments before his altar. They had no habits diſtinct from the reſt of the people; yet in the ceremony of removing the ark to Solomon's temple, the chantors appeared dreſſed in tunics of byſſus or fine linen. 2. Chron. v. 12.

CHANTRY, or Chauntry, was anciently a church or chapel endowed with lands, or other yearly revenue, for the maintenance of one or more prieſts, daily ſaying or ſinging maſs for the ſouls of the donors, and ſuch others as they appointed. Hence *chauntry-rents* are rents paid to the crown by the tenants or purchaſers of *chantry-lands*.

CHAOLOGY, the hiſtory or deſcription of the chaos. See Chaos.

Orpheus, in his chaology, ſets forth the different alterations, ſecretions, and diverſe forms, which matter went through till it became inhabitable, which amounts to the ſame with what we otherwiſe call *coſmogony*. Dr Burnet, in his theory of the earth, repreſents the chaos as it was at firſt, entire, undivided, and univerſally rude and deformed; or the *tohu bohu*: then ſhows how it came to be divided into its reſpective regions; how the homogeneous matter gathered itſelf apart from all of a contrary principal; and, laſtly, how it hardened and became a ſolid habitable globe. See Earth.

CHAOS, that confuſion in which matter lay when newly produced out of nothing at the beginning of the world, before God, by his almighty word, had put it into the order and condition wherein it was after the ſix days creation. See Earth.

Chaos is repreſented by the ancients as the firſt principal, ovum, or ſeed of nature and the world. All the ſophiſts, ſages, naturaliſts, philoſophers, theologues, and poets, held that chaos was the eldeſt and firſt principle, το αρχαιον χαος. The Barbarians, Phœnicians, Egyptians, Perſians, &c. all refer the origin of the world to a rude, mixed, confuſed maſs of matter. The Greeks, Orpheus, Heſiod, Menander, Ariſtophanes, Euripides, and the writers of the Cyclic Poems, all ſpeak of the firſt chaos; the Ionic and Platonic philoſophers build the world out of it. The Stoics hold, that as the world was firſt made of a chaos, it ſhall at laſt be reduced to a chaos; and that its periods and revolutions in the mean time are only tranſitions from one chaos to another. Laſtly, The Latins, as Ennius, Varro, Ovid, Lucretius, Statius, &c. are all of the ſame opinion. Nor is there any ſect or nation whatever that does not derive their διακοσμησις, *the ſtructure of the world*, from a chaos.

The opinion firſt aroſe among the Barbarians, whence it ſpread to the Greeks, and from the Greeks to the Romans and other nations. Dr Burnet obſerves, that beſides Ariſtotle and a few other Pſeudo Pythagoreans, nobody ever aſſerted that our world was always from eternity of the ſame nature, form, and ſtructure, as at preſent; but that it had been the ſtanding opinion of the wiſe men of all ages, that what we now call the *terreſtrial earth*, was originally an unformed, indigeſted maſs of heterogeneous matter, called *chaos;* and no more than the rudiments and materials of the preſent world.

It does not appear who firſt broached the notion of a chaos. Moſes, the eldeſt of all writers, derives the origin of this world from a confuſion of matter, dark, void, deep, without form, which he calls *tohu bohu;* which is preciſely the chaos of the Greek and Barbarian philoſophers. Moſes goes no further than the chaos, nor tells us whence it took its orgin, or whence its confuſed ſtate; and where Moſes ſtops, there preciſely do all the reſt. Dr Burnet endeavours to ſhow that as the ancient philoſophers, &c. who wrote of the coſmogony, acknowledged a chaos for the principal of their world; ſo the divines, or writers of the theogony, derive the origin or generation of their fabled gods from the ſame principle.

Mr Whiſton ſuppoſed the ancient chaos, the origin of our earth, to have been the atmoſphere of a comet; which, though new, yet, all things conſidered, is not the moſt improbable aſſertion. He endeavours to make it out by many arguments, drawn from the agreement which appears to be between them. So that, according to him, every planet is a comet, formed into a regular and laſting conſtitution, and placed at a proper diſtance from the ſun, revolving in a nearly circular orbit: and a comet is a planet either beginning to be deſtroyed or re-made; that is, a chaos or planet unformed or in its primeval ſtate, and placed as yet in an orbit very eccentrical.

Chaos, in the phraſe of Paracelſus, imports the air. It has alſo ſome other ſignifications amongſt the alchemiſts.

Chaos, in *Zoology*, a genus of inſects belonging to the order of vermes zoophyta. The body has no ſhell or covering, and is capable of reviving after being dead to appearance for a long time: it has no joints or external organs of ſenſation. There are five ſpecies, moſtly obtained by infuſions of different vegetables in water, and only diſcoverable by the microſcope. See Animalculæ.

CHAPEAU, in *Heraldry*, an ancient cap of dignity worn by dukes, being ſcarlet-coloured velvet on the outſide, and lined with a fur. It is frequently borne above a helmet inſtead of a wreath, under gentlemen's creſts.

CHAPEL, a place of divine worſhip, ſo called. The word is derived from the Latin *capella*. In former times, when the kings of France were engaged in war, they always carried St Martin's hat into the field, which was kept in a tent as a precious relick: from whence the place was called *capella;* and the prieſts, who had the cuſtody of the tent, *capellani*. Afterwards the word *capella* became applied to private oratories.

In Britain there are ſeveral ſorts of chapels. 1. Parochial chapels; theſe differ from pariſh churches only in name; they are generally ſmall, and the inhabitants within the diſtrict few. If there be a preſentation *ad eccleſiam* inſtead of *capellam*, and an admiſſion and inſtitution upon it, it is no longer a chapel, but a church. 2. Chapels, which adjoin to, and are part of the church: ſuch were formerly built by honourable perſons, as burying places for themſelves and their families. 3. Chapels of eaſe: theſe are uſually built in very large pariſhes, where all the people cannot conveniently repair to the mother church. 4. Free chapels; ſuch as were founded by kings of England. They are free from all epiſcopal juriſdiction, and only to be viſited by the founder and his ſucceſſors; which is done by the lord chancellor: yet the king may licenſe any ſubject to build and endow a chapel, and by letters patent exempt it from the viſitation of the ordinary. 5. Chapels in the univerſities, belonging to particular colleges. 6. Domeſtic chapels, built by noblemen or gentlemen for the private ſervice of God in their families. See Chaplain.

Chapel is alſo a name given to a printer's workhouſe; becauſe, according to ſome authors, printing was firſt actually performed in chapels or churches; or, according to others, becauſe Caxton, an early printer, exerciſed the art in one of the chapels in Weſtminſter abbey. In this ſenſe they ſay, *the orders or laws of the chapel, the ſecrets of the chapel*, &c.

Knights of the Chapel, called alſo *Poor knights of Windſor*, were inſtituted by Henry VIII. in his teſtament. Their number was at firſt thirteen, but has been ſince augmented to 26. They aſſiſt in the funeral ſervices of the kings of England: they are ſubject to the office of the canons of Windſor, and live on penſions aſſigned them by the order of the Garter. They bear a blue or red cloak, with the arms of St George on the left ſhoulder.

CHAPELAIN, James, an eminent French poet, born at Paris in 1595, and often mentioned in the works of Balzac, Menage, and other learned men. He wrote ſeveral works, and at length diſtinguiſhed himſelf by a heroic poem called *La Pucelle, ou France Delivré*, which employed him ſeveral years; and which, raiſing the expectation of the public, was as much decried by ſome as extolled by others. He was one of the king's counſellors; and died in 1647, very rich, but was very covetous and ſordid.

CHAPELET, in the manege, a couple of ſtirrup-leathers, mounted each of them with a ſtirrup, and joined at top in a ſort of leather buckle, called the *head of the chapelet*, by which they are made faſt to the pummel of the ſaddle, after being adjuſted to the rider's length and bore. They are uſed both to avoid the trouble of taking up or letting down the ſtirrups every time that the gentleman mounts on a different horſe and ſaddle, and to ſupply the place of the academy ſaddles, which have no ſtirrups to them.

CHAPELLE, Claudius Emanuel Luillier, the natural ſon of Francis Luillier, took the name of *Chapelle* from a village between Paris and St Denys, where he was born. He diſtinguiſhed himſelf by writing ſmall pieces of poetry, in which he diſcovered great delicacy, an eaſy turn, and an admirable felicity of expreſſion He was the friend of Gaſſendi and Moliere: and died in 1686.

CHAPERON, Chaperonne, or Chaperoon, properly ſignifies a ſort of hood or covering for the head, anciently worn both by men and women, the nobles and the populace, and afterwards appropriated to the doctors and licentiates in colleges, &c. Hence the name paſſed to certain little ſhields, and other funeral devices, placed on the foreheads of the horſes that drew the herſes in pompous funerals, and which are ſtill called *chaperoons* or *ſhafferoons*; becauſe ſuch devices were originally faſtened on the *chaperonnes*, or hoods, worn by thoſe horſes with their other coverings of ſtate.

Chaperon *of a bit-mouth*, in the manege, is only uſed for ſcatch-mouths, and all others that are not cannon-mouths, ſignifying the end of the bit that joins to the branch juſt by the banquet. In ſcatch-mouths the chaperon is round, but in others it is oval: and the ſame part that in ſcatch and other mouths is called *chaperon*, is in cannon-mouths called *fronçeau*.

CHAPITERS, in *Architecture*, the ſame with capitals.

Chapiters, in *Law*, formerly ſignified a ſummary of ſuch matters as were inquired of, or preſented before juſtices in eyre, juſtices of aſſize, or of the peace, in their ſeſſions.

Chapiters, at this time, denotes ſuch articles as are delivered by the mouth of the juſtice in his charge to the inqueſt.

CHAPLAIN properly ſignifies a perſon provided with a chapel, or who diſcharges the duty thereof.

Chaplain is alſo uſed for an eccleſiaſtical perſon, in the houſe of a prince, or a perſon of quality, who officiates in their chapels, &c.

In England there are 48 chaplains to the king, who wait four each month, preach in the chapel, read the ſervice to the family, and to the king in his private oratory, and ſay grace in the abſence of the clerk of the cloſet. While in waiting they have a table and attendance, but no ſalary. In Scotland the king has ſix chaplains, with a ſalary of 50l. each, three of them having in addition the deanery of the chapel-royal divided between them, making up above 100l. to each. The only duty at preſent is to ſay prayers at the election of peers for Scotland to ſit in parliament.—According to a ſtatute of Henry VIII. the perſons veſted with a power of retaining chaplains, together with the number each is allowed to qualify, is as follows: An archbiſhop, eight; a duke or biſhop, ſix; marquis or earl, five; viſcount, four; baron, knight of the garter, or lord chancellor, three; a ducheſs, marchioneſs, counteſs, baroneſs, the treaſurer and comptroller of the king's houſe, clerk of the cloſet, the king's ſecretary, dean of the chapel, almoner, and maſter of the rolls, each of them two; chief juſtice of the king's bench, and warden of the cinque-ports, each one. All theſe chaplains may purchaſe a licenſe or diſpenſation, and take two benefices with cure of ſouls. A chaplain muſt be retained by letters teſtimonial under hand and ſeal; for it is not ſufficient that he ſerve as chaplain in the family.

The firſt chaplains are ſaid to have been thoſe inſtituted by the ancient kings of France, for preſerving the chape, or cape, with the other relicks of St Martin, which the kings kept in their palace, and carried out with them to the war. The firſt chaplain is ſaid to have been Gul. de Meſmes, chaplain to St Louis.

Chaplain *in the order of Malta*, is uſed for the ſecond rank or claſs in that order; otherwiſe called *diaco*.

The knights make the firſt claſs, and the chaplains the ſecond.

Chaplains *of the Pope*, are the auditors, or judges of cauſe in the ſacred palace; ſo called, becauſe the pope anciently gave audience in his chapel, for the deciſion of caſes ſent from the ſeveral parts of Chriſtendom. He hither ſummoned as aſſeſſors the moſt learned lawyers of his time; and they hence acquired the appellation of *capellani*, chaplains. It is from the decrees formerly given by theſe that the body of decretals is compoſed: their number Pope Sixtus IV. reduced to twelve.

Some ſay, the ſhrines of relicks were covered with a kind of tent-cape, or *capella*, i. e. little cape; and that hence the prieſts, who had the care of them, were called chaplains. In time theſe relicks were repoſited in a little church, either contiguous to a larger or ſeparate from it; and the ſame name, *capella*, which was given to the cover, was alſo given to the place where it was lodged: and hence the prieſt who ſuperintended it came to be called chaplain.

CHAPLET, an ancient ornament for the head, like a garland or wreath: but this word is frequently uſed to ſignify the circle of a crown. There are inſtances of its being borne in a coat of arms, as well as for creſts; the paternal arms for Laſcelles are argent, three chaplets, gules.

Chaplet alſo denotes a ſtring of beads uſed by the Roman Catholics, to count the number of their prayers. The invention of it is aſcribed to Peter the hermit, who probably learned it of the Turks, as they owe it to the Eaſt Indians.

Chaplets are ſometimes called *pater-noſters*; and are made of coral, of diamonds, of wood, &c. The common chaplet contains 50 ave-marias, and five pater-noſters. There is alſo a chaplet of our Saviour, conſiſting of 33 beads, in honour of his 33 years living on the earth, inſtituted by Father Michael of Camalduſian.

The Orientals have a kind of chaplets which they call *chains*, and which they uſe in their prayers, rehearſing one of the perfections of God on each link or head. The Great Mogul is ſaid to have 18 of theſe chains, all precious ſtones; ſome diamonds, others rubies, pearls, &c. The Turks have likewiſe chaplets, which they bear in the hand, or hang at the girdle: but Father Dandini obſerves, they differ from thoſe uſed by the Romaniſts, in that they are all of the ſame bigneſs, and have not that diſtinction into decades, though they conſiſt of ſix decades, or 60 heads. He adds, that the Muſſelmans run over the chaplet almoſt in an inſtant, the prayers being extremely ſhort, as containing only theſe words, "praiſe to God," or "glory to God," for each bead. Beſides the common chaplet they have likewiſe a larger one conſiſting of 100 beads, where there is ſome diſtinction, as being divided by little threads into three parts; on one of which they repeat 30 times *ſoubhan Allah*, i. e. "God is worthy to be praiſed;" on another, *ellamh Allah*, "Glory be to God:" and on the third, *Allah echer*, "God is great." Theſe thrice thirty times making only 90; to complete the number 100, they add other prayers for the beginning of the chaplet.—He adds, that the Mahometan chaplet appears to have had its riſe from the *mea beracoth*, or "hundred benedictions," which the Jews are obliged to repeat daily, and which we find in their prayer books; the Jews and Mahometans having this in common, that they ſcarce do any thing without pronouncing ſome laud or benediction.

Menage derives the word *chaplet* from *chapeau*, "hat." The modern Latins call it *chapellina*, the Italians more frequently *corona*.

Chaplet, or *Chapelet*, in *Architecture*, a little moulding, cut or carved into round beads, pearls, olives, or the like.

CHAPMAN, George, born in 1557, a man highly eſteemed in his time for his dramatic and poetic works. He wrote 17 plays; tranſlated Homer and ſome other ancient poets; and was thought no mean genius. He died in 1634; and was buried in St Giles's in the Fields, where his friend Inigo Jones erected a monument to him.

CHAPPE, in *Heraldry*, the dividing an eſcutcheon by lines drawn from the centre of the upper edge to the angles below, into three parts, the ſections on the ſides being of different metal or colour from the reſt.

CHAPPEL *in* frith, a market-town of Derbyſhire, about 26 miles north-weſt of Derby. W. Long. 1. 50. N. Lat. 53. 22.

Chappel, *William*, a learned and pious biſhop of Cork, Cloyne, and Roſs in Ireland, born in Nottinghamſhire in 1582. When the troubles began under Charles I. he was proſecuted by the puritan party in parliament, and retired to Derby, where he devoted himſelf to ſtudy till his death in 1649. He wrote *Methodus Concionandi*, i. e. "the Method of Preaching:" and he is one of thoſe to whom the *Whole Duty of Man* has been attributed. He left behind him alſo his own life written by himſelf in Latin, which has been twice printed.

CHAPTER, in eccleſiaſtical polity, a ſociety or community of clergymen belonging to the cathedrals and collegiate churches.

It was in the eighth century that the body of canons began to be called a chapter. The chapter of the canons of a cathedral were a ſtanding council to the biſhop, and, during the vacancy of the ſee, had the juriſdiction of the dioceſe. In the earlier ages, the biſhop was head of the chapter; afterwards abbots and other dignitaries, as deans, provoſts, treaſurers, &c. were preferred to this diſtinction. The deans and chapters had the privilege of chooſing the biſhops in England; but Henry VIII. got this power veſted in the crown: and as the ſame prince expelled the monks from the cathedrals, and placed ſecular canons in their room, thoſe he thus regulated were called deans and chapters of the new foundation; ſuch are Canterbury, Wincheſter, Ely, Carliſle, &c. See Dean.

Chapter, in matters in literature, a diviſion in a book for keeping the ſubject treated of more clear and diſtinct.

CHAR, in *Ichthyology*, a ſpecies of Salmo.

CHARA. See Botany *Index*.

CHARABON, a ſea port town on the northern coaſt of the iſland of Java in the Eaſt Indies. E. Long. 10. 8. S. Lat. 6.

CHARACENE, the moſt ſouthern part of Suſiana, a province of Perſia, lying on the Perſian gulf, between the Tigris and the Eulæus. It was ſo named from the city of Chorax, called firſt Alexandria, from its founder Alexander the Great; afterwards Antiochia, from Antiochus V. king of Syria, who repaired and beautified it; and laſtly, Chorax Spaſinæ, or Paſinæ, that is, the Mole of the Spaſines, an Arabian king of that name having ſecured it againſt the overflowing of the Tigris, by a high bank or mole, extending three miles, which ſerved as a fence to all that country. Dionyſius Periegetes, and Iſidorus, author of the Parthicæ Manſiones, were both natives of this city. The ſmall diſtrict of Characene was ſeized by Paſines, the ſon of Sogdonacus, king of the neighbouring Arabs, during the troubles of Syria, and erected into a kingdom. Lucian calls him Hyſpaſines, and adds, that he ruled over the Characeni and the neighbouring people: he died in the 85th year of his age. The other kings of this country we find mentioned by the ancients are, Teræus, who died in the 92d year of his age, and after him Artabazus the ſeventh, as Lucian informs us, who was driven from the throne by his own ſubjects, but reſtored by the Parthians. And this is all we find in the ancients relating to the kings of Characene.

CHARACTER, in a general ſenſe, ſignifies a mark or figure, drawn on paper, metal, ſtone, or other matter, with a pen, graver, chiſſel, or other inſtrument, to ſignify or denote any thing. The word is Greek, χαρακτηρ, formed from the verb, χαρασσων, *inſculpere*, "to engrave, impreſs," &c.

The various kinds of characters may be reduced to three heads, viz. *Literal Characters*, *Numeral Characters*, and *Abbreviations*.

I. *Literal* Character, is a letter of the alphabet, ſerving to indicate ſome articulate ſound, expreſſive of ſome idea or conception of the mind. See Alphabet.

1. Theſe may be divided, with regard to their nature and uſe, into *Nominal Characters*, or thoſe we properly call *letters*; which ſerve to expreſs the names of things: See Letter. *Real Characters*; thoſe that inſtead of names expreſs things and ideas: See Idea, &c. *Emblematical* or *Symbolical Characters*: which have this in common with real ones, that they expreſs the things themſelves; but have thus further, that they in ſome meaſure perſonate them, and exhibit their form: ſuch are the hieroglyphics of the ancient Egyptians. See Hieroglyphic, Symbol, &c.

2. *Literal* Characters may be again divided, with regard to their invention and uſe, into *particular* and *general* or *univerſal*.

Particular Characters, are thoſe peculiar to this or that nation. Such are the Roman, Italic, Greek, Hebrew, Arabic, Gothic, Chineſe, &c. *characters*.—See Hebrew, Gothic, Chinese, &c.

Univerſal CHARACTERS, are alſo *real characters*, and make what ſome authors call a *Philoſophical Language*.

That diverſity of *characters* uſed by the ſeveral nations to expreſs the ſame idea, is found the chief obſtacle to the advancement of learning: to remove this, ſeveral authors have taken occaſion to propoſe plans of *characters* that ſhould be univerſal, and which each people ſhould read in their own language. The *character* here is to be real, not nominal: to expreſs things and notions; not, as the common ones, letters or ſounds: yet to be mute, like letters, and arbitrary; not emblematical, like hieroglyphics.

Thus, every nation ſhould retain its own language, yet every one underſtand that of each other, without learning it; only by ſeeing a real or univerſal *character*, which ſhould ſignify the ſame things to all people, by what ſounds ſoever each expreſs it in their particular idiom. For inſtance, by ſeeing the *character* deſtined to ſignify *to drink*, an Engliſhman ſhould read *to drink*; a Frenchman, *boire*; a Latin, *bibere*; a Greek πινειν; a Jew, שתה; a German, *trincken*; and ſo of the reſt; in the ſame manner as ſeeing a horſe, each people expreſſes it after their own manner; but all mean the ſame animal.

This real *character* is no chimera; the Chineſe and Japaneſe have already ſomething like it. They have a common *character* which each of thoſe nations underſtand alike in their ſeveral languages; though they pronounce them with ſuch different ſounds, that they do not underſtand one another in ſpeaking.

The firſt and moſt conſiderable attempt for a *real character*, or philoſophical language, in Europe, are thoſe of Biſhop Wilkins and Dalgarme: but theſe, with how much art ſoever they were contrived, have yet proved ineffectual.

M. Leibnitz had ſome thoughts the ſame way; he thinks thoſe great men did not hit the right method. It was probable, indeed, that by their means, people, who do not underſtand one another might eaſily have a commerce together; but they have not hit on true *real characters*.

According to him, the *characters* ſhould reſemble thoſe uſed in algebra: which, in effect, are very ſimple, yet very expreſſive; without any thing ſuperfluous or equivocal; and contain all the varieties required.

The *real character* of Biſhop Wilkins has its juſt applauſe: Dr Hook recommends it on his own knowledge and experience, as a moſt excellent ſcheme; and, to engage the world to the ſtudy thereof, publiſhes ſome fine inventions of his own therein.

M. Leibnitz tells us, he had under conſideration an *alphabet of human thoughts*; in order to a new philoſophical language, on his own ſcheme: but his death prevented its being brought to maturity.

M. Lodwic, in the Philoſophical Tranſactions, gives us a plan of *an univerſal alphabet* or *character* of another kind: this was to contain an enumeration of all ſuch ſingle ſounds, or letters, as are uſed in any language; by means whereof, people ſhould be enabled to pronounce truly and readily any language; to deſcribe the pronunciation of any language that ſhall be pronounced in their hearing, ſo as others accuſtomed to this language, though they had never heard the language pronounced, ſhall at firſt be able truly to pronounce it: and, laſtly, this *character* to ſerve as a ſtandard to perpetuate the ſounds of any language. In the Journal Litteraire, *an.* 1720, we have a very ingenious project for an univerſal *character*. The author, after obviating the objections that might be made againſt the feaſibleneſs of ſuch ſchemes in the general, propoſes his own: his *characters* are to be the common Arabic, or numeral figures. The combinations of theſe nine are ſufficient to expreſs diſtinctly an incredible quantity of numbers, much more than we ſhall need terms to ſignify our actions, goods, evils, duties, paſſions, &c. Thus is all the trouble of framing and learning any new *character* at once ſaved; the Arabic figures having already all the univerſality required.

The advantages are immenſe. For, 1*mo*, We have here a ſtable, faithful interpreter; never to be corrupted or changed, as the popular languages continually are. 2*do*, Whereas the difficulty of pronouncing a foreign language is ſuch as uſually gives the learner the greateſt trouble, and there are even ſome ſounds which foreigners never attain to, in the *character* here propoſed this difficulty has no place: every nation is to pronounce them according to the particular pronunciation that already obtains among them. All the difficulty is, the accuſtoming the pen and the eye to affix certain notions to *characters* that do not, at firſt ſight, exhibit them. But this trouble is no more than we find in the ſtudy of any language whatever.

The inflections of words are here to be expreſſed by the common letters. For inſtance, the ſame *character* ſhall expreſs a *filly* or a *colt*, a *horſe* or a *mare*, an *old horſe* or an *old mare*, as accompanied with this or that diſtinctive letter, which ſhall ſhow the ſex, youth, maturity, or old age: a letter alſo to expreſs the bigneſs or ſize of things; thus *v. g.* a man with this or that letter, to ſignify a *great man*, or a *little man*, &c.

The uſe of thoſe letters belongs to the grammar; which, once well underſtood, would abridge the vocabulary exceedingly. An advantage of this grammar is, that it would only have one declenſion and one conjugation: thoſe numerous anomalies of grammarians are exceeding troubleſome; and ariſe hence, that the common languages are governed by the populace, who never reaſon on what is beſt: but in the *character* here propoſed, men of ſenſe having the introduction of it, would have a new ground, whereon to build regularly.

A new univerſal character has been propoſed by Mr Northmore of London, by which different nations may communicate their ſentiments to each other. His original plan was, to make the ſame numerical figure repreſent the ſame word in all languages. But he found afterwards that it might be improved, by uſing a figure not for every word, but every *uſeful* word. And even theſe he thinks might be abbreviated by adopting certain uniform fixed ſigns, the number of which would not exceed 20, for the various parts of ſpeech. Words of negation, he propoſed, to be expreſſed by a prefixed ſign. A few inſtances will explain the author's meaning.

Suppoſe the number 5 to repreſent the word *ſee*,

6	—	—	*a man*,
7	—	—	*happy*,
8	—	—	*never*,
9	—	—	*I*

" I would then (ſays he) expreſs the tenſes, genders, caſes, &c. *in all languages*, in ſome ſuch *uniform* manner as the following :

(1) 5 = *preſent tenſe*, — ſee,
(2) $\cdot 5$ = *perfect tenſe*, — ſaw,
(3) $:5$ = *perfect participle*, — ſeen,
(4) $5:$ = *preſent participle*, — ſeeing,
(5) $5\cdot$ = *future*, — — will ſee,
(6) $\underline{5}$ = *ſubſtantive*, — ſight,
(7) $\underline{\underline{5}}$ = *perſonal ſubſtantive*, — ſpectator,
(8) 6 = *nominative caſe*, — a man,
(9) $\ddot{6}$ = *genitive*, — of a man,
(10) $\dddot{6}$ = *dative*, — — to a man,
(11) $\overset{\frown}{6}$ = *feminine*, — — a woman,
(12) $+6$ = *plural*, — — men,
(13) 7 = *poſitive*, — — happy,
(14) $\hat{7}$ = *comparative*, — happier,
(15) $\overset{\wedge\wedge}{7}$ = *ſuperlative*, — happieſt,
$\underline{7}$ = as above, N° 6. — happineſs,
(16) -7 = *negation*, — — unhappy,

" From the above ſpecimen, I ſhould find no difficulty in comprehending the following ſentence, though it were written in the language of the Hottentots: $9, 8, .5, -\hat{7}, \overset{\frown}{6}$. *I never ſaw a more unhappy woman.*

" Thoſe languages which do not uſe the pronoun prefixed to the verb, as the Greek and Roman, &c. may apply it, in a ſmall character, ſimply to denominate the perſon ; thus, inſtead of 9, 8, .5, *I never ſaw ;* they may write, $8, {}_{9}.5$, which will ſignify that the verb is in the firſt perſon, and will ſtill have the ſame meaning."

Our author thinks, that according to this ſcheme of an univerſal character, about 20 ſigns, and leſs than 10,000 *choſen* words (ſynonyms being ſet aſide), would anſwer all the ends propoſed ; and that foreigners, by referring to their numerical dictionary, would eaſily comprehend each other. He proceeds next to ſhew how appropriate ſounds may be given to his ſigns, and an univerſal *living language* formed from the univerſal *characters*.

To attain this end, he propoſes to diſtinguiſh the ten numerals by ten monoſyllabic names of eaſy pronunciation, and ſuch as may run without difficulty into one another. To illuſtrate his ſcheme, however, he calls them, for the preſent, by their common Engliſh names ; but would pronounce each number made uſe of by uttering ſeparately its component parts, after the manner of accountants. Thus, let the number 6943 repreſent the word *horſe*, he would not, in the univerſal language, call a horſe *ſix thouſand nine hundred and forty three*, but *ſix*, *nine*, *four*, *three*, and ſo on for all the words of a ſentence, making the proper ſtop at the end of each. In the ſame manner, a diſtinct appellation muſt be appropriated to each of the prefixed ſigns, to be pronounced immediately after the numeral to which it is an appendage. Thus, if *plu* be the appellation or the ſign of the plural number, *ſix*, *nine*, *four*, *three*, *plu* will be *horſes*.

" Thus (ſays our author), I hope, it is evident that about 30 or 40 diſtinct ſyllables are ſufficient for the above purpoſe ; but I am much miſtaken if *eleven* only will not anſwer the ſame end. This is to be done by ſubſtituting the firſt 20 or 30 numerals for the ſigns, and ſaying, as in algebra, that a term is in the power of ſuch a number, which may be expreſſed by the ſimple word *under*. *Ex. gr.* Let 6943 repreſent the word *horſe ;* and ſuppoſe 4 to be the ſign of the plural number, I would write the word thus, $\frac{4}{6943}$; and pronounce it, ſix, nine, four, three, in the power of or *under* four. By theſe means eleven diſtinct appellations would be ſufficient, and time and uſe would much abbreviate the pronunciation."

But the difficulty is not in inventing the moſt ſimple, eaſy, and commodious *character*, but in engaging the ſeveral nations to uſe it ; there being nothing they agree leſs in, than the underſtanding and purſuing their common intereſt.

3. Literal characters may again be divided, with reſpect to the nations among whom they have been invented, into Greek characters, Roman characters, Hebrew characters, &c. The Latin character now uſed through all Europe, was formed from the Greek, as the Greek was from the Phœnician ; and the Phœnician, as well as the Chaldee, Syriac, and Arabic characters, were formed from the ancient Hebrew, which ſubſiſted till the Babyloniſh captivity ; for after that event the character of the Aſſyrians, which is the ſquare Hebrew now in uſe, prevailed, the ancient being only found on ſome Hebrew medals, commonly called Samaritan medals. It was in 1091 that the Gothic characters, invented by Ulfilas, were aboliſhed, and the Latin ones eſtabliſhed in their room.

Medalliſts obſerve, that the Greek character, conſiſting only of majuſcule letters, has preſerved its uniformity on all medals, as low as the time of Gallienus, from which time it appears ſomewhat weaker and rounder : from the time of Conſtantine to Michael we find only Latin characters : after Michael, the Greek characters recommence ; but from that time they began to alter with the language, which was a mixture of Greek and Latin The Latin medals preſerved both their characters and language as low as the tranſlation of the ſeat of the empire to Conſtantinople : towards the time of Decius the character began to loſe its roundneſs and beauty ; ſome time after, it retrieved and ſubſiſted tolerably till the time of Juſtin, when it degenerated gradually into the Gothic. The rounder, then, and better formed a character is upon a medal, the fairer pretence it has to antiquity.

II. *Numeral* CHARACTERS, or characters uſed to expreſs numbers, are either letters or figures.

The Arabic character, called alſo the common one, becauſe it is uſed almoſt throughout Europe in all ſorts of calculations, conſiſts of theſe ten digits, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

The Roman numeral character conſiſts of ſeven majuſcule letters of the Roman alphabet, viz. I, V, X, L, C, D, M. The I denotes one, V five, X ten, L fifty, C a hundred, D five hundred, and M a thouſand. The I repeated twice makes two, II ; thrice, three, III. Four is expreſſed thus, IV. as I before V or X takes an unit from the number expreſſed by theſe letters To expreſs ſix, an I is added to a V, VI.; for ſeven, two, VII.; and for eight, three, VIII. Nine is expreſſed by an I before X, thus IX. The ſame remark may be made of the X before L or C, except that the diminution is by tens; thus, XL denotes forty, XC ninety, and LX ſixty. The C before D or M diminiſhes each by a hundred. The number five hundred is ſometimes expreſſed by an I before a C inverted, thus, IↃ; and inſtead of M, which ſignifies a thouſand, an I is ſometimes uſed between two C's, the one direct, and the other inverted, thus, CIↃ. The addition of C and Ↄ before or after raiſes CIↃ by tens; thus, CCIↃↃ expreſſes ten thouſand, CCCIↃↃↃ a hundred thouſand. The Romans alſo expreſſed any number of thouſands by a line drawn over any numeral leſs than a thouſand; thus, $\overline{V}$ detotes five thouſand, $\overline{LX}$ ſixty thouſand; ſo likewiſe $\overline{M}$ is one million, $\overline{MM}$ is two millions, &c.

The Greeks had three ways of expreſſing numbers: 1. Every letter, according to its place in the alphabet, denoted a number, from α, one, to ω, twenty-four. 2. The alphabet was divided into eight units, α one, β two, γ three, &c.; into eight tens, ι ten, κ tweuty, λ thirty, &c.; and eight hundreds, ρ one hundred, σ two hundred, τ three hundred, &c. 3. Ι ſtood for one, Π five, Δ ten, Η a hundred, Χ a thouſaud, Μ ten thouſand; and when the letter Π encloſed any of theſe, except Ι, it ſhowed the encloſed letter to be five times its value; as, $|\overline{\Delta}|$ fifty, $|\overline{H}|$ five hundred, $|\overline{X}|$ five thouſand, $|\overline{M}|$ fifty thouſand.

The French CHARACTERS uſed in the chamber of accounts, and by perſons concerned in the management of the revenue, is properly ſpeaking, nothing elſe than the Roman numerals, in letters that are not majuſcule: thus, inſtead of expreſſing fifty-ſix by LVI, they denote it by ſmaller characters, lvj.

III. CHARACTERS of Abbreviations, &c. in ſeveral of the arts, are ſymbols contrived for the more conciſe and immediate conveyance of the knowledge of things. For the

CHARACTERS uſed in Algebra, ſee **ALGEBRA**, Introduction.

Of the Aſpects.

☌ or S Conjunction
SS Semiſextile
* Sextile
Q Quintile
□ Quartile
Td Tredecile
△ Trine
Bq Biquintile
Vc Quincunx
☍ Oppoſition
☊ Dragon's head
☋ Dragon's tail

Of Time.

A. M. *ante meridiem*, before the ſun comes upon the meridian.
O. or N. noon.
P.M. *poſt meridiem*, when the ſun is paſt the meridian.

CHARACTERS in Commerce.

D^{o} *ditto*, the ſame
N^{o} *numero*, or number
F^{o} *folio*, or page
C or [illegible] hundred weight, or 112 pounds
q^{rs} quarters
S or *s* ſhillings
d pence or deniers
℔ pound weight
R^{o} *recto* } *folio*
V^{o} *vero* }
£. or *l.* pounds ſterling
p^{r} *per* or by, p^{r} *ann.* by the year, p^{r} *cent.*
R^{x} rixdollar
D^{c} ducat
P. S. poſtſcript, &c.

CHARACTERS in Geometry and Trigonometry.

∥ the character of parallelilſm
△ triangle
□ ſquare
▯ ▭ rectangle
⊙ circle
≚ equiangular or ſimilar
$\overset{\perp}{=}$ equilateral
∠ an angle
∟ right angle
⊥ perpendicular

° denotes a degree; thus, 45° implies 45 degrees. ′ denotes a minute; thus, 50′ is 50 minutes. ″, ‴, ⁗, denote ſeconds, thirds, and fourths: and the ſame characters are uſed when the progreſſions are by tens, as it is here by ſixties.

CHARACTERS in Grammar, Rhetoric, Poetry, &c.

( ) parentheſis
[ ] crotchet
- hyphen
’ apoſtrophe
‘ emphaſis or accent
˘ breve
¨ dialyſis
^ caret and circumflex
† ‡ and * references
§ ſection or diviſion
¶ paragraph
D. D. doctor in divinity
V. D. M. miniſter of the word of God
LL. D. doctor of laws
J. V. D. doctor of civil and common law
“ quotation
M. D. doctor in phyſic
A. M. maſter of arts
A. B. bachelor of arts
F. R. S. fellow of the royal ſociety.

For the other characters uſed in grammar, ſee COMMA, COLON, SEMICOLON, &c.

CHARACTERS among the ancient Lawyers, and in ancient Inſcriptions

§ paragraph
ff digeſts
Scto. ſenatus conſulto
E. extra
. P. Q. R. ſenatus populuſque Romanus
P. P. pater patria
C. Code
C. C. conſules
T. titulus
P. P. D. D. propria pecunia dedicavit
D. D. M. dono dedit monumentum

CHARACTERS in Medicine and Pharmacy.

℞ recipe
$\bar{a}$, $\overline{aa}$, or ana, of each alike
℔ a pound, or a pint
℥ an ounce
ʒ a drachm
℈ a ſcruple
gr. grains
ß or *ſs* half of any thing
cong. congius, a gallon
coch. cochleare, a ſpoonful
M. manipulus, a handful
P. a pugil
P. Æ. equal quantities
S. A. according to art
q. s. a ſufficient quantity
q. pl. as much as you pleaſe
P. P. pulvis patrum, the Jeſuits bark.

CHARACTERS upon Tomb-ſtones.

S. V. Siſte viator, *i. e.* Stop traveller.
M. S. Memoriæ ſacrum, *i. e.* Sacred to the memory.

D M. Diis manibus.

J. H. S. Jeſus.

X. P. a character found in the catacombs, about the meaning of which authors are not agreed.

Characters uſed in Muſic, and of Muſical Notes with their proportions, are as follows.

𝆷	character of a large	8	𝅘𝅥	crotchet	$\frac{1}{4}$
𝆸	a long	4	𝅘𝅥𝅮	quaver	$\frac{1}{8}$
𝅜	a breve	2	𝅘𝅥𝅯	ſemiquaver,	$\frac{1}{16}$
𝅝	a ſemibreve	1	𝅘𝅥𝅰	demiſemiquaver	$\frac{1}{32}$
𝅗𝅥	a minim	½			

✻ character of a ſharp note; this character at the beginning of a line or ſpace, denotes that all the notes in that line are to be taken a ſemitone higher than in the natural ſeries; and the ſame affects all the octaves above and below, though not marked: but when prefixed to any particular note, it ſhows that note alone to be taken a ſemitone higher than it would be without ſuch a character.

♭ or *b*, character of a flat note: this is the contrary to the other above; that is, a ſemitone lower.

♮ character of a natural note: when in a line or ſeries of artificial notes, marked at the beginning ♭ or ✻, the natural note happens to be required, it is denoted by this character.

𝄞 character of the treble cliff.

𝄡 character of the mean cliff.

𝄢 baſs cliff.

$\frac{2}{4}$ or $\frac{4}{8}$, characters of common duple time, ſignifying the meaſure of two crotchets to be equal to two notes, of which four make a ſemibreve.

𝄴 𝄵 Ↄ characters that diſtinguiſh the movements of common time, the firſt implying ſlow, the ſecond quick, and the third very quick.

$\frac{1}{2}$, $\frac{1}{3}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{3}{16}$, characters of ſimple triple time, the meaſure of which is equal to three ſemibreves, or to three minims.

$\frac{4}{6}$, $\frac{6}{8}$, or $\frac{6}{16}$, characters of a mixed triple time, where the meaſure is equal to ſix crotchets, or ſix quavers.

$\frac{9}{4}$, or $\frac{9}{8}$, or $\frac{9}{16}$, or $\frac{9}{1}$, or $\frac{9}{2}$, characters of compound triple time.

$\frac{4}{12}$, $\frac{8}{12}$, $\frac{12}{16}$, or $\frac{1}{12}$, or $\frac{2}{12}$, characters of that ſpecies of triple time called the meaſure of twelve times.

Character, in human life, that which is peculiar in the manners of any perſon, and diſtinguiſhes him from all others.

Good Character, is particularly applied to that conduct which is regulated by virtue and religion; in an inferior but very common ſenſe, it is underſtood of mere honeſty of dealing between man and man. The importance of a good character in the commerce of life ſeems to be univerſally acknowledged.—To thoſe who are to make their own way either to wealth or honours, a good character is uſually no leſs neceſſary than addreſs and abilities. To tranſcribe the obſervation of an elegant moraliſt: though human nature is degenerate, and corrupts itſelf ſtill more by its own inventions; yet it uſually retains to the laſt an eſteem for excellence. But even if we are arrived at ſuch an extreme degree of depravity as to have loſt our native reverence for virtue; yet a regard to our own intereſt and ſafety, which we ſeldom loſe, will lead us to apply for aid, in all important tranſactions, to men whoſe integrity is unimpeached. When we chooſe an aſſiſtant, a partner, a ſervant, our firſt inquiry is concerning his character. When we have occaſion for a counſellor or attorney, a phyſician or apothecary, whatever we may be ourſelves, we always chooſe to truſt our property and perſons to men of the beſt character. When we fix on the tradeſmen who are to ſupply us with neceſſaries, we are not determined by the ſign of the lamb, or the wolf, or the fox, nor by a ſhop fitted up in the moſt elegant taſte; but by the faireſt reputation. Look into a daily newſpaper, and you will ſee, from the higheſt to the loweſt rank, how important the characters of the employed appear to the employers. After the advertiſement has enumerated the qualities required in the perſon wanted, there conſtantly follows, that none need apply who cannot bring an undeniable character. Offer yourſelf as a candidate for a ſeat in parliament, be promoted to honour and emolument, or in any reſpect attract the attention of mankind upon yourſelf, and if you are vulnerable in your character, you will be deeply wounded. This is a general teſtimony in favour of honeſty, which no writings and no practices can poſſibly refute.

Young men, therefore, whoſe characters are yet unfixed, and who conſequently may render them juſt ſuch as they wiſh, ought to pay great attention to the firſt ſteps which they take on entrance into life. They are uſually careleſs and inattentive to this object. They purſue their own plans with ardour, and neglect the opinions which others entertain of them. By ſome thoughtleſs action or expreſſion, they ſuffer a mark to be impreſſed upon them, which ſcarcely any ſubſequent merit can entirely eraſe. Every man will find ſome perſons, who, though they are not profeſſed enemies, yet view him with an envious or a jealous eye, and who will gladly revive any tale to which truth has given the ſlighteſt foundation.

In this turbulent and confuſed ſcene, where our words and actions are often miſunderſtood, and oftener miſrepreſented, it is indeed difficult even for innocence and integrity to avoid reproach, abuſe, contempt, and hatred. Theſe not only hurt our intereſt and impede our advancement in life, but ſorely afflict the feelings of a delicate and tender mind. It is then the part of wiſdom firſt to do every thing in our power to preſerve an irreproachable character, and then to let our happineſs depend chiefly on the approbation of our own conſciences, and on the advancement of our intereſt in a world where liars ſhall not be believed, and where ſlanders ſhall receive countenance from none but him who, in Greek, is called by way of eminence, *Diabolus*, or the calumniator.

Character, in *Poetry*, particularly the epopee and drama, is the reſult of the manners or peculiarities by which each perſon is diſtinguiſhed from others.

The poetical character, ſays M. Boſſu, is not properly any particular virtue or quality, but a compoſition of ſeveral which are mixed together, in a different degree, according to the neceſſity of the fable and the unity of the action: there muſt be one, however, to reign over all the reſt; and this muſt be found, in ſome degree, in every part. The firſt quality in Achilles, is wrath; in Ulyſſes, diſſimulation; and in

Æneas, mildneſs: but as theſe characters cannot be alone, they muſt be accompanied with others to embelliſh them, as far as they are capable, either by hiding their defects. as in the anger of Achilles, which is palliated by extraordinary valour: or by making them centre in ſome ſolid virtue, as in Ulyſſes, whoſe diſſimulation makes a part of his prudence; and in Æneas, whoſe mildneſs is employed in a ſubmiſſion to the will of the gods. In the making up of which union, it is to be obſerved, the poets have joined together ſuch qualities as are by nature the moſt compatible; valour with anger, piety with mildneſs, and prudence with diſſimulation. The fable required prudence in Ulyſſes, and piety in Æneas; in this, therefore, the poets were not left to their choice: but Homer might have made Achilles a coward without abating any thing from the juſtneſs of his fable; ſo that it was the neceſſity of adorning his character, that obliged him to make him valiant: the character, then, of a hero in the epic poem, is compounded of three ſorts of qualities: the firſt eſſential to the fable; the ſecond, embelliſhments of the firſt; and valour, which ſuſtains the other two, makes the third.

Unity of character is as neceſſary as the unity of the fable. For this purpoſe a perſon ſhould be the ſame from the beginning to the end: not that he is always to betray the ſame ſentiments, or one paſſion; but that he ſhould never ſpeak nor act inconſiſtently with his fundamental character. For inſtance, the weak may ſometimes ſally into a warmth, and the breaſt of the paſſionate be calm, a change which often introduces in the drama a very affecting variety: but if the natural diſpoſition of the former was to be repreſented as boiſterous, and that of the latter mild and ſoft, they would both act out of character, and contradict their perſons.

True characters are ſuch as we truly and really ſee in men, or may exiſt without any contradiction to nature: no man queſtions but there have been men as generous and as good as Æneas, as paſſionate and as violent as Achilles, as prudent and wiſe as Ulyſſes, as impious and atheiſtical as Mezentius, and as amorous and paſſionate as Dido; all theſe characters, therefore, are true, and nothing but juſt imitations of nature. On the contrary, a character is falſe when an author ſo feigns it, that one can ſee nothing like it in the order of nature wherein he deſigns it ſhall ſtand: theſe characters ſhould be wholly excluded from a poem, becauſe tranſgreſſing the bounds of probability and reaſon, they meet with no belief from the readers; they are fictions of the poet's brain, not imitations of nature; and yet all poetry conſiſts of an imitation of nature.

CHARACTER is alſo uſed for certain viſible qualities, which claim reſpect or reverence to thoſe veſted therewith.—The majeſty of kings gives them a character which procures reſpect from the people. A biſhop ſhould ſuſtain his character by learning and ſolid piety, rather than by worldly luſtre, &c. The law of nations ſecures the character of an ambaſſador from all inſults.

CHARACTER, among naturaliſts, is ſynonymous with the definition of the genera of animals, plants, &c.

CHARACTERISTIC, in general, is that which characterizes a thing or perſon, i. e. conſtitutes its character, whereby it is diſtinguiſhed. See CHARACTER.

CHARACTERISTIC, is peculiarly uſed in grammar, for the principal letter of a word: which is preſerved in moſt of its tenſes and moods, its derivatives and compounds.

CHARACTERISTIC of a Logarithm, is its index or exponent. See LOGARITHM.

CHARACTERISTIC Triangle of a Curve, in the higher geometry, is a rectilinear right-angled triangle, whoſe hypothenuſe makes a part of the curve, not ſenſibly different from a right line. It is ſo called, becauſe curve lines are uſed to be diſtinguiſhed hereby. See CURVE.

CHARADE, the name of a new ſpecies of compoſition or literary amuſement. It owes its name to the idler who invented it. Its ſubject muſt be a word of two ſyllables, each forming a diſtinct word: and theſe two ſyllables are to be concealed in an enigmatical deſcription, firſt ſeparately, and then together. The exerciſe of charades, if not greatly inſtructive, is at leaſt innocent and amuſing. At all events, as it has made its way into every faſhionable circle, and has employed even Garrick, it will ſcarcely be deemed unworthy of attention. The ſillineſs indeed of moſt that have appeared in the papers under this title, are not only deſtitute of all pleaſantry in the ſtating, but are formed in general of words utterly unfit for the purpoſe. They have therefore been treated with the contempt they deſerved. In trifles of this nature, inaccuracy is without excuſe. The following examples therefore are at leaſt free from this blemiſh.

I.

My *firſt*, however here abuſed,
Deſigns the ſex alone;
In Cambria, ſuch is cuſtom's pow'r,
'Tis Jenkin, John, or Joan.
My *ſecond* oft is loudly call'd,
When men prepare to ſift it:
Its name delights the female ear;
Its force, may none reſiſt it!
It binds the weak, it binds the ſtrong,
The wealthy and the poor;
Still 'tis to joy a paſſport deem'd,
For ſullied fame a cure.
It may enſure an age of bliſs,
Yet mis'ries oft attend it;
To fingers, ears, and noſes too,
Its various lords commend it.
My *whole* may chance to make one drink,
Though vended in a fiſh ſhop;
'Tis now the monarch of the ſeas,
And has been an archbiſhop. *Her-ring.*

II.

My *firſt*, when a Frenchman is learning Engliſh, ſerves him to ſwear by. My *ſecond*, is either hay or corn. My *whole*, is the delight of the preſent age; and will be the admiration of poſterity. *Gar-rick.*

III.

My *firſt*, is plowed for various reaſons, and grain is frequently buried in it to little purpoſe. *My ſecond*, is neither riches nor honours; yet the former would generally be given for it, and the latter is often taſteleſs without it. My *whole* applies equally to ſpring, ſummer, autumn, and winter: and both fiſh and fleſh, praiſe and cenſure, mirth and melancholy, are the better for being in it. *Sea-ſon.*

IV.

My *firſt*, with the moſt rooted antipathy to a Frenchman, prides himſelf, whenever they meet, upon ſticking cloſe to his jacket. My *ſecond*, has many virtues, nor is it its leaſt that it gives name to my firſt. My *whole*, may I never catch! *Tar-tar.*

V.

My *firſt*, is one of England's prime boaſts; it rejoices the ear of a horſe, and anguiſhes the toe of a man. My *ſecond*, when brick, is good; when ſtone, better; when *wooden*, beſt of all. My *whole*, is famous alike for rottenneſs and tin. *Corn-wall.*

VI.

My *firſt* is called bad or good,
May pleaſure or offend ye;
My *ſecond*, in a thirſty mood,
May very much befriend ye.
My *whole*, though ſtyled a "cruel word,"
May yet appear a kind one;
It often may with joy be heard,
With tears may often blind one. *Fare-well.*

VII.

My *firſt* is equally friendly to the thief and the lover, the toper and the ſtudent. My *ſecond* is light's oppoſite: yet they are frequently ſeen hand in hand; and their union, if judicious, gives much pleaſure. My *whole*, is tempting to the touch, grateful to the ſight, fatal to the taſte. *Night ſhade.*

CHARADRIUS, the PLOVER and DOTTEREL. See ORNITHOLOGY *Index*.

CHARAG, the tribute which Chriſtians and Jews pay to the grand ſignior.

It conſiſts of ten, twelve, or fifteen francs per annum, according to the eſtate of the party. Men begin to pay it at nine or at ſixteen years old; women are diſpenſed with, as alſo prieſts, rabbins, and religious.

CHARAIMS, a ſect of the Jews in Egypt. They live by themſelves, and have a ſeparate ſynagogue; and as the other Jews are remarkable for their eyes, ſo are thoſe for their large noſes, which run through all the families of this ſect. Theſe are the ancient Eſſenes. They ſtrictly obſerve the five books of Moſes, according to the letter; and receive no written traditions. It is ſaid that the other Jews would join the *Charaims*: but thoſe not having obſerved the exact rules of the law with regard to divorces, theſe think they live in adultery.

CHARANTIA. See MOMORDICA, BOTANY *Index*.

CHARBON, in the manege, that little black ſpot or mark which remains after a large ſpot in the cavity of the corner teeth of a horſe: about the ſeventh or eighth year, when the cavity fills up, the tooth being ſmooth and equal, it is ſaid to be raſed.

CHARCAS, the ſouthern diviſion of Peru in South America, remarkable for the ſilver mines of Potoſi.

CHARCOAL, a ſort of artificial coal, or fuel, conſiſting of wood half burnt; chiefly uſed where a clear ſtrong fire, without ſmoke, is required; the humidity of the wood being here moſtly diſſipated, and exhaled in the fire wherein it is prepared.

The microſcope diſcovers a ſurpriſing number of pores in charcoal: they are diſpoſed in order, and traverſe it lengthwiſe; ſo that there is no piece of charcoal, how long ſoever, but may be eaſily blown through. If a piece be broken pretty ſhort, it may be ſeen through with a microſcope. In a range the 18th part of an inch long, Dr Hook reckoned 150 pores; whence he concludes, that in a charcoal of an inch diameter, there are not leſs than 5,724,000 pores. It is to this prodigious number of pores that the blackneſs of charcoal is owing: for the rays of light ſtriking on the charcoal, are received and abſorbed in its pores, inſtead of being reflected; whence the body muſt of neceſſity appear black, blackneſs in a body being no more than a want of reflection. Charcoal was anciently uſed to diſtinguiſh the bounds of eſtates and inheritances; as being incorruptible, when let very deep within ground. In effect, it preſerves itſelf ſo long, that there are many pieces found entire in the ancient tombs of the northern nations. M. Dodart ſays, there is charcoal made of corn, probably as old as the days of Cæſar: he adds, that it has kept ſo well, that the wheat may be ſtill diſtinguiſhed from the rye; which he looks on as proof of its incorruptibility.

The operation of charring wood is performed in the following manner: The wood intended for this purpoſe is cut into proper lengths, and piled up in heaps near the place where the charcoal is intended to be made: when a ſufficient quantity of wood is thus prepared, they begin conſtructing their ſtacks, for which there are three methods. The firſt is this: They level a proper ſpot of ground, of about 12 or 15 feet in diameter, near the piles of wood; in the centre of this area a large billet of wood, ſplit acroſs at one end and pointed at the other, is fixed with its pointed extremity in the earth, and two pieces of wood inſerted through the clefts of the other end, forming four right angles; againſt theſe croſs pieces four other billets of wood are placed, one end on the ground, and the other leaning againſt the angles. This being finiſhed, a number of large and ſtraight billets are laid on the ground to form a floor, each being as it were the radius of the circular area: on this floor a proper quantity of bruſh or ſmall wood is ſtrewed, in order to fill up the interſtices, when the floor will be complete; and in order to keep the billets in the ſame order and poſition in which they were firſt arranged, pegs or ſtumps are driven into the ground in the circumference of the circle, about a foot diſtant from one another: upon this floor a ſtage is built with billets ſet upon one end, but ſomething inclining towards the central billet; and on the tops of theſe another floor is laid in a horizontal direction, but of ſhorter billets, as the whole is, when finiſhed, to form a cone.

The ſecond method of building the ſtacks for making charcoal is performed in this manner: A long pole is erected in the centre of the area above deſcribed, and ſeveral ſmall billets ranged round the pole on their ends: the interſtices between theſe billets and the pole is filled with dry bruſhwood, then a floor is laid on that ſtage, in a reclining poſition, and on that a ſecond floor, &c. in the ſame manner as deſcribed above; but in the lower floor there is a billet larger and longer than the reſt, extending from the central pole to ſome diſtance beyond the circumference of the circle.

The third method is this: A chimney, or aperture of a ſquare form, is built with billets in the centre, from the bottom to the top; and round theſe, floors and inclined ſtages are erected, in the ſame manner as in the ſtacks above deſcribed, except that the baſe of this, inſtead of being circular like the others, is ſquare; and the whole ſtack, when completed, forms a pyramid.

The ſtack of either form being thus finiſhed, is coated over with turf, and the ſurface plaſtered with a mixture of earth and charcoal duſt well tempered together.

The next operation is the ſetting the ſtack on fire. In order to this, if it be formed according to the firſt conſtruction, the central billet in the upper ſtage is drawn out, and ſome pieces of very dry and combuſtible wood are placed in the void ſpace, called, by workmen, the chimney, and fire ſet to theſe pieces. If the ſtack be built according to the ſecond conſtruction, the central pole is drawn out, together with the large horizonal billet above deſcribed; aud the void ſpace occupied by the latter being filled with pieces of very dry combuſtible wood, the fire is applied to it at the baſe of the ſtack. With regard to the third conſtruction, the ſquare aperture or chimney is filled with ſmall pieces of very dry wood, and the fire applied to it at the top or apex of the pyramidal ſtack. When the ſtack is ſet on fire, either at the top or bottom, the greateſt attention is neceſſary in the workman; for in the proper management of the fire the chief difficulty attending the art of making good charcoal conſiſts. In order to this, care is taken, as ſoon as the flame begins to iſſue ſome height above the chimney, that the aperture be covered with a piece of turf, but not ſo cloſe as to hinder the ſmoke from paſſing out; and whenever the ſmoke appears to iſſue very thick from any part of the pile, the aperture muſt be covered with a mixture of earth and charcoal duſt. At the ſame time, as it is neceſſary that every part of the ſtack ſhould be equally burnt, it will be requiſite for the workman to open vents in one part and ſhut them in another. In this manner the fire muſt be kept up till the charcoal be ſufficiently burnt, which will happen in about two days and a half if the wood be dry; but if green, the operation will not be finiſhed in leſs than three days. When the charcoal is thought to be ſufficiently burnt, which is eaſily known from the appearance of the ſmoke, and the flames no longer iſſuing with impetuoſity through the vents; all the apertures are to be cloſed up very carefully with a mixture of earth and charcoal duſt, which, by excluding all acceſs of the external air, prevents the coals from being any further conſumed, and the fire goes out of itſelf. In this condition it is ſuffered to remain, till the whole is ſufficiently cooled; when the cover is removed, and the charcoal is taken away. If the whole proceſs is ſkilfully managed, the coals will exactly retain the figure of the pieces of wood: ſome are ſaid to have been ſo dexterous as to char an arrow without altering even the figure of the feather.

There are conſiderable differences in the coals of different vegetables, in regard to their habitude to fire: the very light coals of linen, cotton, ſome fungi, &c. readily catch fire from a ſpark, and ſoon burn out; the more denſe ones of woods and roots are ſet on fire more difficultly, and burn more ſlowly: the coals of the black berry-bearing alder, of the hazel, the willow, and the lime tree, are ſaid to anſwer beſt for the making of gunpowder and other pyrotechnical compoſitions, perhaps from their being eaſily inflammable: for the reduction of metallic calces thoſe of the heavier woods, as the oak and the beech, are preferable, theſe ſeeming to contain a larger proportion of the phlogiſtic principle, and that, perhaps, in a more fixed ſtate; conſidered as common fuel, thoſe of the heavy woods give the greateſt heat, and require the moſt plentiful ſupply of air to keep them burning; thoſe of the light woods preſerve a glowing heat, without much draught of air, till the coals themſelves are conſumed; the bark commonly crackles and flies about in burning, which the coal of the wood itſelf very ſeldom does.

Mathematical inſtrument makers, engravers, &c. find charcoal of great uſe to poliſh their braſs and copper plates after they have been rubbed clean with powdered pumice ſtone. Plates of horn are poliſhable in the ſame way, and a gloſs may be afterwards given with tripoli.

The coals of different ſubſtances are alſo uſed as pigments; hence the bone-black, ivory-black, &c. of the ſhops. Moſt of the paints of this kind, beſides their incorruptibility, have the advantage of a full colour, and work freely in all the forms in which powdery pigments are applied; provided they have been carefully prepared, by thoroughly burning the ſubject in a cloſe veſſel, and afterwards grinding the coal into a powder of due fineneſs. Pieces of charcoal are uſed alſo in their entire ſtate for tracing the outlines of drawings, &c.; in which intentiou they have an excellence, that their mark is eaſily wiped out. For theſe purpoſes, either the finer pieces of common charcoal are picked out and cut to a proper ſhape; or the pencils are formed of wood, and afterwards burnt into charcoal in a proper veſſel well covered. The artiſts commonly make choice of the ſmaller branches of the tree freed from the bark and pith; and the willow and vine are preferred to all others. This choice is confirmed by the experiments of Dr Lewis, who has found that the wood of the trunks of trees produces charcoal of a harder nature than their ſmall twigs or branches; and the hard woods, ſuch as box and guiacum, produced coals very ſenſibly harder than the ſofter woods. Willow he prefers to all others. The ſhells and ſtones of fruits yielded coals ſo hard that they would ſcarce mark on paper at all; while the coals of the kernels of fruits were quite ſoft and mellow. The ſeveral coals produced by the doctor's experiments were levigated into fine powder, mixed both with gum water and oil, and applied as paints both thin and thick, and diluted with different degrees of white. All of them, when laid on thick, appeared of a ſtrong full black, nor could it be judged that one was of a finer colour than another; diluted with white, or when ſpread thin, they had all ſomewhat of a bluiſh caſt.

Philoſoph. Commerce of Arts.

Horns and the bones, both of fiſhes and land animals, gave coals rather gloſſier and deeper coloured than vegetables; and which, in general, were very hard, ſo as difficultly, or not at all, to ſtain paper. Here alſo the hardneſs of the coal ſeemed to depend on that of the ſubject from whence it was prepared; for ſilk, woollen, leather, blood, and the fleſhy parts of animals, yielded ſoft coals. Some of theſe differed from others very ſenſibly in colour; that of ivory is ſuperior to all the reſt, and indiſputably the fineſt of all the charcoal blacks. The animal coals had much leſs of the bluiſh caſt in them than the vegetable, many of them inclining rather to a brown. Charred pit coal, on the other hand, ſeemed to have this blueneſs in a greater degree. For the chemical properties of charcoal ſee Chemistry *Index*.

CHARDIN, Sir John, a celebrated traveller, was born at Paris in 1643. His father, who was a jeweller, had him educated in the Proteſtant religion; after which he travelled into Perſia and India. He traded in jewels, and died at London in 1713. The account he wrote of his travels is much eſteemed.

CHARENTON, the name of two towns of France, the one upon the Marmaude in the Bourbonnois; the other in the Iſle of France, near the confluence of the Marne with the Seine.

CHARES the Lydian, a celebrated ſtatuary, was the diſciple of Lyſippus; and made the famous Coloſſus of the ſun in the city of Rhodes. Flouriſhed 288 years before Chriſt.

CHARGE, in *Gunnery*, the quantity of powder and ball wherewith a gun is loaded for execution.

The rules for charging large pieces in war are, That the piece be firſt cleaned or ſcoured within-ſide: that the proper quantity of powder be next driven in and rammed down; care, however, being taken, that the powder, in ramming, be not bruiſed, becauſe that weakens its effect: that a little quantity of paper, hay, lint, or the like, be rammed over it: and that the ball or ſhot be intruded. If the ball be red hot, a tompion, or trencher of green wood, is to be driven in before it. The common allowance for a charge of powder of a piece of ordnance, is half the weight of the ball. In the Britiſh navy, the allowance for 32 pounders is but ſeven ſixteenths of the weight of the bullet. But a late author is of opinion, that if the powder in all ſhip-cannon whatever was reduced to one-third weight of the ball, or even leſs, it would be of conſiderable advantage, not only by ſaving ammunition, but by keeping the guns cooler and quieter, and at the ſame time more effectually injuring the veſſels of the enemy. With the preſent allowance of powder the guns are heated, and their tackle and furniture ſtrained; and this only to render the bullets leſs efficacious: for a bullet which can but juſt paſs through a piece of timber, and loſes almoſt all its motion thereby, has a much better chance of rending and fracturing it, than if it paſſes through with a much greater velocity.

Robins' Propoſal for increaſing the ſtrength of the Navy.

Charge, in *Heraldry*, is applied to the figures repreſented on the eſcutcheon, by which the bearers are diſtinguiſhed from one another; and it is to be obſerved, that too many charges are not ſo honourable as fewer.

Charge of Lead, denotes a quantity of 36 pigs. See Pig.

To Charge, in the military language, is to attack the enemy either with horſe or foot.

Charge, in *Law*, denotes the inſtructions given to the grand jury, with reſpect to the articles of their inquiry, by the judge who preſides on the bench.

Charge, in *Law*, alſo ſignifies a thing done that bindeth him who doth it; and diſcharge is the removal of that charge. Lands may be charged in various ways; as, by grant of rent out of it, by ſtatutes, judgments, conditions, warranties, &c.

Charge of horning, in *Scots Law*. See Horning.

Charge to enter Heir, in *Scots Law*, a writing paſſing under the ſignet, obtained at the inſtance of a creditor, either againſt the heir of his debtor, for fixing upon him the debt as repreſenting the debtor, which is called a general charge; or, againſt the debtor himſelf, or his heir, for the purpoſe of veſting him in the right of an heritable ſubject to which he has made up no title, in order the creditor may attach that ſubject for payment of his debt, in the ſame manner as if his debt or his heir were legally veſted in it by ſervice or otherwiſe. This laſt kind is called a *ſpecial charge*.

Charge, or rather *Overcharge*, in painting, is an exaggerated repreſentation of any perſon; wherein the likeneſs is preſerved, but at the ſame time ridiculed.

Few painters have the genius neceſſary to ſucceed in theſe charges: the method is, to ſelect and heighten ſomething already amiſs in the face, whether by way of defect, or redundancy: thus, *v. g.* if Nature hath given a man a noſe a little larger than ordinary, the painter falls in with her, and makes the noſe extravagantly long: or if the noſe be naturally too ſhort, in the painting it will be a mere ſtump; and thus of the other parts.

CHARGED, in *Heraldry*, a ſhield carrying ſome impreſs or figure, is ſaid to be charged therewith; ſo alſo, when one bearing, or charge, has another figure added upon it, it is properly ſaid to be charged.

Charged, in electrical experiments, is when a phial, pane of glaſs, or other electric ſubſtance, properly coated on both ſides, has a quantity of electricity communicated to it; in which caſe the one ſide is always electrified poſitively, and the other negatively.

CHARIOT, a half coach, having only a ſeat behind, with a ſtool before. See Coach.

The chariots of the ancients, chiefly uſed in war, were called by the ſeveral names of *bigæ*, *trigæ*, &c. according to the number of horſes applied to draw them. Every chariot carried two men, who were probably the warrior and the charioteer; and we read of ſeveral men of note and valour employed in driving the chariot. When the warriors came to encounter in cloſe fight, they alighted out of the chariot, and fought on foot; but when they were weary, which often happened by reaſon of their armour, they retired into their chariot, and thence annoyed their enemies with darts and miſſile weapons. Theſe chariots were made ſo ſtrong, that they laſted for ſeveral generations.

Beſides this ſort, we find frequent mention of the *currus falcati*, or thoſe chariots armed with hooks or ſcythes, with which whole ranks of ſoldiers were cut off together, if they had not the art of avoiding the danger; theſe were not only uſed by the Perſians, Syrians, Egyptians, &c. but we find them among the ancient

cient Britons; and notwithſtanding the imperfect ſtate of ſome of the moſt neceſſary arts among that nation before the invaſion of the Romans, it is certain that they had war chariots in great abundance. By the Greek and Roman hiſtorians, theſe chariots are deſcribed by the ſix following names: viz. Benna, Petoritum, Currus or Carrus, Covinus, Eſſedum, and Rheda. The benna ſeems to have been a chariot deſigned rather for travelling than war. It contained two perſons, who were called *combennones*, from their ſitting together in the ſame machine. The petoritum ſeems to have been a larger kind of chariot than the benna; and is thought to have derived its name from the Britiſh word *pedwar*, ſignifying *four*; this kind of carriage having four wheels. The carrus or currus was the common cart or waggon. This kind of chariot was uſed by the ancient Britons, in times of peace, for the purpoſes of agriculture and merchandiſe, and, in time of war, for carrying their baggage, and wives and children, who commonly followed the armies of all the Celtic nations. The covinus was a war chariot, and a very terrible inſtrument of deſtruction; being armed with ſharp ſcythes and hooks for cutting and tearing all who were ſo unhappy as to come within its reach. This kind of chariot was made very ſlight, and had few or no men in it beſides the charioteer; being deſigned to drive with great force and rapidity, and to do execution chiefly with its hooks and ſcythes. The eſſedum and rheda were alſo war chariots, probably of a large ſize, and ſtronger made than the covinus, deſigned for containing a charioteer for driving it, and one or two warriors for fighting. The far greateſt number of the Britiſh war chariots ſeem to have been of this kind. Theſe chariots, as already obſerved, were to be found in great numbers among the Britons; inſomuch, that Cæſar relates, that Caſſibelanus, after diſmiſſing all his other forces, retained no fewer than 4000 of theſe war chariots about his perſon. The ſame author relates, that, by continual experience, they had at laſt arrived at ſuch perfection in the management of their chariots, that "in the moſt ſteep and difficult places they could ſtop their horſes upon full ſtretch, turn them which way they pleaſed, run along the pole, reſt on the harneſs, and throw themſelves back into their chariots, with incredible dexterity."

Chariots, in the heathen mythology, were ſometimes conſecrated to the ſun; and the Scripture obſerves, that Joſiah burnt thoſe which had been offered to the ſun by the kings his predeceſſors. This ſuperſtitious cuſtom was an imitation of the heathens, and principally of the Perſians, who had horſes and chariots conſecrated in honour of the ſun. Herodotus, Xenophon, and Quintus Curtius, ſpeak of white chariots crowned, which were conſecrated to the ſun, among the Perſians, which in their ceremonies were drawn by white horſes conſecrated to the ſame luminary.

Triumphal Chariot, was one of the principal ornaments of the Roman celebration of a victory.

The Roman triumphal chariot was generally made of ivory, round like a tower, or rather of a cylindrical figure; it was ſometimes gilt at the top, and ornamented with crowns; and to repreſent a victory more naturally, they uſed to ſtain it with blood. It was uſually drawn by four white horſes; but oftentimes by lions, elephants, tygers, bears, leopards, dogs, &c.

CHARISIA, in the heathen theology, a wake, or night feſtival, inſtituted in honour of the Graces. It continued the whole night, moſt of which time was ſpent in dancing; after which, cakes made of yellow flour mixed with honey, and other ſweatmeats, were diſtributed among the aſſiſtants.—Chariſia is alſo ſometimes uſed to ſignify the ſweatmeats uſed on ſuch occaſions.

CHARISIUS, in the heathen theology, a ſurname given to Jupiter. The word is derived from χαρις, *gratia*, "grace" or "favour;" he being the god by whoſe influence men obtain the favour and affection of one another. On which account the Greeks uſed at their meals to make a libation of a cup to Jupiter Chariſius.

CHARISTIA, a feſtival of the ancient Romans, celebrated in the month of February, wherein the relations by blood and marriage met, in order to preſerve a good correſpondence; and that if there happened to be any difference among them, it might be the more eaſily accommodated by the good humour and mirth of the entertainment. *Ovid. Faſt.* i. 617.

CHARISTICARY, commendatory, or donatory, a perſon to whom is given the enjoyment of the revenues of a monaſtery, hoſpital, or benefice.

The Chariſticaries among the Greeks, were a kind of donatories, or commendatories, who enjoyed all the revenues of hoſpitals and monaſteries without giving an account thereof to any perſon.—The original of this abuſe is referred to the Iconoclaſtæ, particularly Conſtantine Copronymus, the avowed enemy of the monks, whoſe monaſteries he gave away to ſtrangers. In after times, the emperors and patriarchs gave many to people of quality, not by way of gift to reap any temporal advantage from them, but to repair, beautify, and patronize them. At length avarice crept in, and thoſe in good condition were given away, eſpecially ſuch as were rich; and at laſt they were all given away, rich and poor, thoſe of men and of women, and that to laymen and to married men.

CHARITY, among divines, one of the three grand theological virtues, conſiſting in the love of God and of our neighbour, or the habit and diſpoſition of loving God with all our heart, and our neighbour as ourſelves.

Charity is alſo uſed for the effect of a moral virtue, which conſiſts in ſupplying the neceſſities of others, whether with money, counſel, aſſiſtance, or the like.

As pecuniary relief is generally the moſt efficacious, and at the ſame time that from which we are moſt apt to excuſe ourſelves, this branch of the duty merits particular illuſtration; and a better cannot be offered than what is contained in the following extracts (if we may be permitted to make them) from the elegant *Moral Syſtem* of Archdeacon *Paley*.

Whether pity be an inſtinct or a habit, it is in fact a property of our nature, which God appointed; and the final cauſe for which it was appointed, is to afford to the miſerable, in the compaſſion of their fellow-creatures, a remedy for thoſe inequalities and diſtreſſes which God foreſaw that many muſt be expoſed to, under every general rule for the diſtribution of property.

The Chriſtian Scriptures are more copious and explicit upon this duty than almoſt any other. The deſcription which Chriſt hath left us of the proceedings of the laſt day, eſtabliſhes the obligation of bounty beyond controverſy. "When the Son of Man ſhall come in his glory, and all the holy angels with him, then ſhall he ſit upon the throne of his glory, and before him ſhall be gathered all nations; and he ſhall ſeparate them one from another. Then ſhall the King ſay unto them on his right hand, Come ye bleſſed of my Father, inherit the kingdom prepared for you from the foundation of the world: For I was hungered, and ye gave me meat; I was thirſty, and ye gave me drink; I was a ſtranger, and ye took me in; naked, and ye clothed me; I was ſick, and ye viſited me; I was in priſon, and ye came unto me. And inaſmuch as ye have done it to one of the leaſt of theſe my brethren, ye have done it unto me." It is not neceſſary to underſtand this paſſage as a literal account of what will actually paſs on that day. Suppoſing it only a ſcenical deſcription of the rules and principles by which the Supreme Arbiter of our deſtiny will regulate his deciſions, it conveys the ſame leſſon to us; it equally demonſtrates of how great value and importance theſe duties in the ſight of God are, and what ſtreſs will be laid upon them. The apoſtles alſo deſcribe this virtue as propitiating the divine favour in an eminent degree. And theſe recommendations have produced their effect. It does not appear that, before the times of Chriſtianity, an infirmary, hoſpital, or public charity of any kind, exiſted in the world; whereas moſt countries in Chriſtendom have long abounded with theſe inſtitutions. To which may be added, that a ſpirit of private liberality ſeems to flouriſh amidſt the decay of many other virtues: not to mention the legal proviſion for the poor, which obtains in this country, and which was unknown and unthought of by the moſt poliſhed nations of antiquity.

St Paul adds upon the ſubject an excellent direction; and which is practicable by all who have any thing to give. "Upon the firſt day of the week (or any other ſtated time) let every one of you lay by in ſtore, as God hath proſpered him." By which the apoſtle may be underſtood to recommend what is the very thing wanting with moſt men, *the being charitable upon a plan*; that is, from a deliberate compariſon of our fortunes with the reaſonable expences and expectations of our families. to compute what we can ſpare, and to lay by ſo much for charitable purpoſes, in ſome mode or other. The mode will be a conſideration afterwards.

The effect which Chriſtianity produced upon ſome of its converts, was ſuch as might be looked for from a divine religion coming with full force and miraculous evidence upon the conſciences of mankind. It overwhelmed all worldly conſiderations in the expectation of a more important exiſtence. "And the multitude of them that believed were of one heart and of one ſoul; neither ſaid any of them that aught of the things which he poſſeſſed was his own; but they had all things in common.—Neither was there any among them that lacked; for as many as were poſſeſſors of lands or houſes ſold them, and brought the prices of the things that were ſold, and laid them down at the apoſtles feet; and diſtribution was made unto every man according as he had need." Acts iv. 32.

Nevertheleſs, this community of goods, however it manifeſted the ſincere zeal of the primitive Chriſtians, is no precedent for our imitation. It was confined to the church at Jeruſalem; continued not long there; was never enjoined upon any (Acts v. 4.); and, although it might ſuit with the particular circumſtances of a ſmall and ſelect ſociety, is altogether impracticable in a large and mixed community.

The conduct of the apoſtles upon the occaſion deſerves to be noticed. Their followers laid down their fortunes at their feet: but ſo far were they from taking advantage of this unlimited confidence to enrich themſelves or eſtabliſh their authority, that they ſoon after got rid of this buſineſs as inconſiſtent with the main object of their miſſion, and transferred the cuſtody and management of the public fund to deacons elected to that office by the people at large (Acts vi).

There are three kinds of charity, our author obſerves, which prefer a claim to attention.

1. The firſt, and apparently one of the beſt, is to give ſtated and conſiderable ſums, by way of penſion or annuity to individuals or families, with whoſe behaviour and diſtreſs we ourſelves are acquainted. In ſpeaking of conſiderable ſums, it is meant only, that five pounds, or any other ſum, given at once, or divided amongſt five or fewer families, will do more good than the ſame ſum diſtributed amongſt a greater number in ſhillings or half crowns; and that, becauſe it is more likely to be properly applied by the perſons who receive it. A poor fellow who can find no better uſe for a ſhilling than to drink his benefactor's health, and purchaſe half an hour's recreation for himſelf, would hardly break into a guinea for any ſuch purpoſe, or be ſo improvident as not to lay it by for an occaſion of importance, for his rent, his clothing, fuel, or ſtock of winter's proviſion. It is a ſtill greater recommendation of this kind of charity, that penſions and annuities, which are paid regularly, and can be expected at the time, are the only way by which we can prevent one part of a poor man's ſufferings, the dread of want.

2. But as this kind of charity ſuppoſes that proper objects of ſuch expenſive benefactions fall within our private knowledge and obſervation, which does not happen to all, a ſecond method of doing good, which is in every one's power who has the money to ſpare, is by ſubſcription to public charities. Public charities admit of this argument in their favour, that your money goes farther towards attaining the end for which it is given, than it can do by any private and ſeparate beneficence. A guinea, for example, contributed to an infirmary, becomes the means of providing one patient, at leaſt, with a phyſician, ſurgeon, apothecary, with medicine, diet, lodging, and ſuitable attendance; which is not the tenth part of what the ſame aſſiſtance, if it could he procured at all, would coſt to a ſick perſon or family in any other ſituation.

3. The laſt, and compared with the former, the loweſt exertion of benevolence, is in the relief of beggars. Nevertheleſs, the indiſcriminate rejection of all who implore our alms, in this way, is by no means approved.

proved. Some may periſh by ſuch a conduct. Men are ſometimes overtaken by diſtreſs, for which all other relief would come too late. Beſides which, reſolutions of this kind compel us to offer ſuch violence to our humanity, as may go near, in a little while, to ſuffocate the principle itſelf; which is a very ſerious conſideration. A good man, if he do not ſurrender himſelf to his feelings without reſerve, will at leaſt lend an ear to importunities which come accompanied with outward atteſtations of diſtreſs; and after a patient hearing of the complaint, will direct himſelf by the circumſtances and credibility of the account that he receives.

There are other ſpecies of charity well contrived to make the money expended *go far;* ſuch as keeping down the price of fuel or proviſions in caſe of a monopoly or temporary ſcarcity, by purchaſing the articles at the beſt market, and retailing them at prime coſt, or at a ſmall loſs; or the adding a bounty to a particular ſpecies of labour, when the price is accidentally depreſſed.

The proprietors of large eſtates have it in their power to facilitate the maintenance, and thereby encourage the eſtabliſhment of families (which is one of the nobleſt purpoſes to which the rich and great can convert their endeavours), by building cottages, ſplitting-farms, erecting manufactures, cultivating waſtes, embanking the ſea, draining marſhes, and other expedients, which the ſituation of each eſtate points out. If the profits of theſe undertakings do not repay the expence, let the authors of them place the difference to the account of charity. It is true of almoſt all ſuch projects, that the public is a gainer by them, whatever the owner be. And where the loſs can be ſpared, this conſideration is ſufficient.

It is become a queſtion of ſome importance, Under what circumſtances works of charity ought to be done in private, and when they may be made public without detracting from the merit of the action? if indeed they ever may, the Author of our religion having delivered a rule upon this ſubject, which ſeems to enjoin univerſal ſecrecy. “When thou doeſt alms, let not thy left hand know what thy right hand doth; that thy alms may be in ſecret: and thy Father which ſeeth in ſecret, himſelf ſhall reward thee openly.” (Matth. vi. 3, 4.). From the preamble to this prohibition, it is plain, that our Saviour's ſole deſign was to forbid *oſtentation*, and all publiſhing of good works which proceeds from that motive. “Take heed that ye do not your alms before men, *to be ſeen of them;* otherwiſe ye have no reward of your Father, which is in heaven; therefore, when thou doeſt thine alms, do not ſound a trumpet before thee, as the hypocrites do, in the ſynagogues and in the ſtreets, *that they may have glory of men.* Verily I ſay unto thee, they have their reward,” v. 2. There are motives for the doing our alms in public beſides thoſe of oſtentation; with which therefore our Saviour's rule has no concern: ſuch as to teſtify our approbation of ſome particular ſpecies of charity, and to recommend it to others; to take off the prejudice which the want, or, which is to the ſame thing, the ſuppreſſion, of our name in the liſt of contributors, might excite againſt the charity or againſt ourſelves. And ſo long as theſe motives are free from any mixture of vanity, they are in no danger of invading our Saviour's prohibition: they rather ſeem to comply with another direction which he has left us: “Let your light ſo ſhine before men, that they may ſee your good works, and glorify you Father which is in heaven.” If it be neceſſary to propoſe a preciſe diſtinction upon the ſubject, there can be none better than the following: When our bounty is beyond our fortune or ſtation, that is, when it is more than could be expected from us, our charity ſhould be private, if privacy be practicable: when it is not more than might be expected, it may be public: for we cannot hope to influence others to the imitation of extraordinary generoſity, and therefore want, in the former caſe, the only juſtifiable reaſon for making it public.

The pretences by which men excuſe themſelves from giving to the poor are various; as,

1. “That they have nothing to ſpare;” i. e. nothing, for which they have not ſome other uſe; nothing, which their plan of expence, together with the ſavings they have reſolved to lay by, will not exhauſt; never reflecting whether it be in their power, or that it is their duty, to retrench their expences, and contract their plan, “that they may have to give to them that need;” or rather that this ought to have been part of their plan originally.

2. “That they have families of their own, and that charity begins at home.” A father is no doubt bound to adjuſt his economy with a view to the reaſonable demands of his family upon his fortune; and until a ſufficiency for theſe is acquired, or in due time probably will be acquired (for in human affairs probability is enough, he is juſtified in declining *expenſive* liberality; for to take from thoſe who want, in order to give to thoſe who want, adds nothing to the ſtock of public happineſs. Thus far, therefore, and no farther, the plea in queſtion is an excuſe for parſimony, and an anſwer to thoſe who ſolicit our bounty.

3. “That charity does not conſiſt in giving money, but in benevolence, philanthropy, love to all mankind, goodneſs of heart,” &c. Hear St James. “If a brother or ſiſter be naked, and deſtitute of daily food, and one of you ſay unto them, Depart in peace, be ye warmed and filled, notwithſtanding *ye give them not thoſe things which are needful for the body*, what doth it profit?” (James ii. 15, 16.)

4. “That giving to the poor is not mentioned in St Paul's deſcription of charity, in the 13th chapter of his firſt epiſtle to the Corinthians.” This is not a deſcription of charity, but of good nature; and it is not neceſſary that every duty be mentioned in every place.

5. “That they pay the poor rates.” They might as well allege that they pay their debts; for the poor have the ſame right to that portion of a man's property which the laws aſſign them, that the man himſelf has to the remainder.

6. “That they employ many poor perſons;”—for their own ſake, not the poor's—otherwiſe it is a good plea.

7. “That the poor do not ſuffer ſo much as we imagine; that education and habit have reconciled them to the evils of their condition, and make them eaſy under it.” Habit can never reconcile human nature to the extremities of cold, hunger, and thirſt, any more than it can reconcile the hand to the touch

of a red-hot iron: beſides the queſtion is not, how unhappy any one is, but how much more happy we can make him?

8. "That theſe people, give them what you will, will never thank you, or think of you for it." In the firſt place, this is not true: in the ſecond place, it was not for the ſake of their thanks that you relieved them.

9. "That we are ſo liable to be impoſed upon." If a due inquiry be made, our motive and merit is the ſame; beſide that the diſtreſs is generally real, whatever has been the cauſe of it.

10. "That they ſhould apply to their pariſhes." This is not always practicable: to which we may add, that there are many requiſites to a comfortable ſubſiſtence, which pariſh-relief does not always ſupply; and that there are ſome who would ſuffer almoſt as much from receiving pariſh-relief as by the want of it; and laſtly, that there are many modes of charity, to which this anſwer does not relate at all.

11. "That giving money encourages idleneſs and vagrancy." This is true only of injudicious and indiſcriminate generoſity.

12. "That we have too many objects of charity at home to beſtow any thing upon ſtrangers; or that there are other charities which are more uſeful, or ſtand in greater need." The value of this excuſe depends entirely upon the *fact*, whether we actually relieve thoſe neighbouring objects, and contribute to thoſe other charities.

Beſides all theſe excuſes, pride, or prudery, or delicacy, or love of eaſe, keep one half of the world out of the way of obſerving what the other half ſuffer.

Charity Schools, are ſchools erected and maintained in various pariſhes by the voluntary contributions of the inhabitants, for teaching poor children to read, write, and other neceſſary parts of education. See School.

Brothers of Charity, a ſort of religious hoſpitallers, founded about the year 1297, ſince denominated *Billetins*. They took the third order of St Francis, and the ſcapulary, making the three uſual vows, but without begging.

Brothers of Charity, alſo denote an order of hoſpitallers, ſtill ſubſiſting in Romiſh countries, whoſe buſineſs is to attend the ſick poor, and miniſter to them both ſpiritual and temporal ſuccour.

They are all laymen, except a few prieſts, for adminiſtering the ſacraments to the ſick in their hoſpitals. The brothers of charity uſually cultivate botany, pharmacy, ſurgery, and chemiſtry, which they practiſe with ſucceſs.

They were firſt founded at Granada, by St John de Dieu; and a ſecond eſtabliſhment was made at Madrid in the year 1553: the order was confirmed by Gregory XIII. in 1572: Gregory XIV. forbade them to take holy orders; but by leave of Paul V. in 1609, a few of the brothers might be admitted to orders. In 1619 they were exempted from the juriſdiction of the biſhop. Thoſe of Spain are ſeparated from the reſt; and they, as well as the brothers of France, Germany, Poland and Italy, have their diſtinct generals, who reſide at Rome. They were firſt introduced into France by Mary of Medicis in 1601, and have ſince built a fine hoſpital in the fauxbourg of Germain.

Charity of St Hippolitus, a religious congregation founded about the end of the 14th century, by one Bernardin Alvarez, a Mexican, in honour of St Hippolitus the martyr, patron of the city of Mexico; and approved by Pope Gregory XIII.

Charity of our Lady, in church hiſtory, a religious order in France, which, though charity was the principal motive of their union, grew in length of time ſo diſorderly and irregular, that their order dwindled, and at laſt became extinct.

There is ſtill at Paris, a religious order of women, called *nuns hoſpitallers of the charity of our lady*. The religious of this hoſpital are by vow obliged to adminiſter to the neceſſities of the poor and the ſick, but thoſe only women.

CHARLATAN, or Charletan, ſignifies an empiric or quack, who retails his medicines on a public ſtage, and draws people about him with his buffooneries, feats of activity, &c. The word, according to Calepine, comes from the Italian, *ceretano*; of *Cæretum*, a town near Spoletto in Italy, where theſe impoſtors are ſaid to have firſt riſen. Menage derives it from *ciarlatano*, and that from *circulatorius*, of *circulator*, a quack.

CHARLEMAGNE, or Charles I. king of France by ſucceſſion, and emperor of the weſt by conqueſt in 800 (which laid the foundation of the dynaſty of the weſtern Franks, who ruled the empire 472 years till the time of Rodolphus Auſpurgenſis, the founder of the houſe of Auſtria). Charlemagne was as illuſtrious in the cabinet as in the field; and, though he could not write his name, was the patron of men of letters, the reſtorer of learning, and a wiſe legiſlator; he wanted only the virtue of humanity to render him the moſt accompliſhed of men; but when we read of his beheading 4500 Saxons, ſolely for their loyalty to their prince, in oppoſing his conqueſts, we cannot think he merits the extravagant encomiums beſtowed on him by ſome hiſtorians. He died in 814, in the 74th year of his age, and 47th of his reign.

France had nine ſovereigns of this name, of whom Charles V. merited the title of *the wiſe* (crowned in 1364, died in 1380): and Charles VIII. ſignalized himſelf in the field by rapid victories in Italy; (crowned in 1483, died in 1498). The reſt do not deſerve particular mention in this place. See (*Hiſtory of*) France.

CHARLEMONT, a town of the province of Namur in the Auſtrian Netherlands, about 18 miles ſouth of Namur. E. Long. 4. 40. N. Lat. 50. 10.

Charlemont is alſo the name of a town of Ireland, ſituated on the river Blackwater, in the county of Armagh, and province of Ulſter, about ſix miles ſouth-eaſt of Dungannon. W. Long. 6. 50. N. Lat. 50. 16.

CHARLEROY, a ſtrong town in the province of Namur in the Auſtrian Netherlands, ſituated on the river Sambre, about 19 miles weſt of Namur. E. Long. 46. 20. N. Lat. 50. 30.

CHARLES Martel, a renowned conqueror in the early annals of France. He depoſed and reſtored

Childeric king of France; and had the entire government of the kingdom, once with the title of *mayor of the palace*, and afterwards as *duke of France;* but he would not accept the crown. He died regretted, in 741.

CHARLES le Gros, emperor of the weſt in 881, king of Italy and Suabia, memorable for his reverſe of fortune; being dethroned at a diet held near Mentz, by the French, the Italians, and the Germans, in 887: after which he was obliged to ſubſiſt on the bounty of the archbiſhop of Mentz. He died in 888.

CHARLES. V. (emperor and king of Spain) was ſon of Philip I. archduke of Auſtria and of Jane queen of Caſtile. He was born at Ghent, February 24. 1500. and ſucceeded to the crown of Spain in 1517. Two years afterwards he was choſen emperor at Francfort after the death of Maximilian his grandfather. He was a great warrior and politician: and his ambition was not ſatisfied with the many kingdoms and provinces he poſſeſſed; for he is ſuppoſed, with reaſon, to have aſpired at univerſal empire. He is ſaid to have fought 60 battles, in moſt of which he was victorious. He took the king of France (Francis I.) priſoner, and ſold him his liberty on very hard terms; yet afterwards, when the people of Ghent revolted, he aſked leave to paſs through his dominions: and though the generous king thus had him in his power, and had an opportunity of revenging his ill treatment, yet he received and attended him with all pomp and magnificence. He ſacked Rome, and took the pope priſoner; and the cruelties which his army exerciſed there are ſaid to have exceeded thoſe of the northern barbarians. Yet the pious emperor went into mourning on account of this conqueſt: forbade the ringing of bells; commanded proceſſions to be made, and prayers to be offered up for the deliverance of the pope his priſoner; yet did not inflict the leaſt puniſhment on thoſe who treated the holy father and the holy ſee with ſuch inhumanity. He is accuſed by ſome Romiſh writers of favouring the Lutheran principles, which he might eaſily have extirpated. But the truth is, he found his account in the diviſions which that ſect occaſioned; and he forever made his advantage of them, ſometimes againſt the pope, ſometimes againſt France, and at other times againſt the empire itſelf. He was a great traveller, and made 50 different journeys into Germany, Spain, Italy, Flanders, France, England, and Africa. Though he had been ſucceſsful in many unjuſt enterpriſes, yet his laſt attempt on Metz, which he beſieged with an army of 100,000 men, was very juſt, and very unſucceſsful.

Vexed at the reverſe of fortune which ſeemed to attend his latter days, and oppreſſed by ſickneſs, which unfitted him any longer for holding the reins of government with ſteadineſs, or to guide them with addreſs, he reſigned his dominions to his brother Ferdinand and his ſon Philip; and retreated to the monaſtery of St Juſtus near Placentia in Eſtremadura.

When Charles entered this retreat, he formed ſuch a plan of life for himſelf as would have ſuited a private gentleman of moderate fortune. His table was neat, but plain; his domeſtics few; his intercourſe with them familiar; all the cumberſome and ceremonious forms of attendance on his perſon were entirely aboliſhed, as deſtructive of that ſocial eaſe and tranquillity which he courted in order to ſoothe the remainder of his days. As the mildneſs of the climate, together with his deliverance from the burdens and cares of government, procured him at firſt a conſiderable remiſſion from the acute pains of the gout, with which he had been long tormented, he enjoyed perhaps more complete ſatisfaction in this humble ſolitude than all his grandeur had ever yielded him. The ambitious thoughts and projects which had ſo long engroſſed and diſquieted him were quite effaced from his mind. Far from taking any part in the political tranſactions of the princes of Europe, he reſtrained his curioſity even from an inquiry concerning them; and he ſeemed to view the buſy ſcene which he had abandoned with all the contempt and indifference ariſing from his thorough experience of its vanity, as well as from the pleaſing reflection of having diſentangled himſelf from its cares.

Other amuſements, and other ſubjects, now occupied him. Sometimes he cultivated the plants in his garden with his own hand; ſometimes he rode out to the neighbouring wood on a little horſe, the only one that he kept, attended by a ſingle ſervant on foot. When his infirmities confined him to his apartment, which often happened, and deprived him of theſe more active recreations, he either admitted a few gentlemen who reſided near the monaſtery to viſit him, and entertained them familiarly at his table; or he employed himſelf in ſtudying mechanical principles, and in forming curious works of mechaniſm, of which he had always been remarkably fond, and to which his genius was peculiarly turned. With this view he had engaged Turriano, one of the moſt ingenious artiſts of that age, to accompany him in his retreat. He laboured together with him in framing models of the moſt uſeful machines, as well as in making experiments with regard to their reſpective powers; and it was not ſeldom that the ideas of the monarch aſſiſted or perfected the inventions of the artiſt. He relieved his mind at intervals with ſlighter and more fantaſtic works of mechaniſm, in faſhioning puppets, which, by the ſtructure of internal ſprings, mimicked the geſtures and actions of men, to the no ſmall aſtoniſhment of the ignorant monks, who, beholding movements which they could not comprehend, ſometimes diſtruſted their own ſenſes, and ſometimes ſuſpected Charles and Turriano of being in compact with inviſible powers. He was particularly curious with regard to the conſtruction of clocks and watches; and having found, after repeated trials, that he could not bring any two of them to go exactly alike, he reflected, it is ſaid, with a mixture of ſurpriſe as well as regret, on his own folly, in having beſtowed ſo much time and labour in the more vain attempt of bringing mankind to a preciſe uniformity of ſentiment concerning the intricate and myſterious doctrines of religion.

But in what manner ſoever Charles diſpoſed of the reſt of his time, he conſtantly reſerved a conſiderable portion of it for religious exerciſes. He regularly attended divine ſervice in the chapel of the monaſtery, every morning and evening; he took great pleaſure in reading books of devotion, particularly the works of St Auguſtine and St Bernard; and converſed much with his confeſſor. and the prior of the monaſtery, on pious ſubjects. Thus did Charles paſs the firſt year of his retreat in a manner not unbecoming a man perfectly diſengaged from the affairs of this preſent life, and ſtanding on the confines of a future world, either in innocent amuſements which ſoothed his pains, and relieved a mind worn out with exceſſive application to buſineſs; or in devout occupations, which he deemed neceſſary in preparing for another ſtate.

But, about ſix months before his death, the gout, after a longer intermiſſion than uſual, returned with a proportional increaſe of violence. His ſhattered conſtitution had not ſtrength enough remaining to withſtand ſuch a ſhock. It enfeebled his mind as much as his body; and from this period we hardly diſcern any traces of that ſound and maſculine underſtanding which diſtinguiſhed Charles among his cotemporaries. An illiberal and timid ſuperſtition depreſſed his ſpirit. He had no reliſh for amuſements of any kind. He endeavoured to conform, in his manner of living, to all the rigour of monaſtic auſterity. He deſired no other ſociety than that of monks, and was almoſt continually employed in chanting with them the hymns of the miſſal. As an expiation for his ſins, he gave himſelf the diſcipline in ſecret, with ſuch ſeverity, that the whip of cords which he employed as the inſtrument of his puniſhment, was found, after his deceaſe, tinged with his blood. Nor was he ſatisfied with theſe acts of mortification, which, however ſevere, were not unexampled. The timorous and diſtruſtful ſolicitude which always accompanies ſuperſtition, ſtill continued to diſquiet him, and depreciating all that he had done, prompted him to aim at ſomething extraordinary, at ſome new and ſingular act of piety, that would diſplay his zeal, and merit the favour of heaven. The act on which he fixed was as wild and uncommon as any that ſuperſtition ever ſuggeſted to a diſordered fancy. He reſolved to celebrate his own obſequies before his death. He ordered his tomb to be erected in the chapel of the monaſtery. His domeſtics marched thither in funeral proceſſion, with black tapers in their hands. He himſelf followed in his ſhroud. He was laid in his coffin with much ſolemnity. The ſervice for the dead was chaunted; and Charles joined in the prayers which were offered up for the reſt of his ſoul, mingling his tears with thoſe which his attendants ſhed, as if they had been celebrating a real funeral. The ceremony cloſed with ſprinkling holy water on the coffin in the uſual form, and, all the aſſiſtants retiring, the doors of the chapel were ſhut. Then Charles roſe out of the coffin, and withdrew to his apartment, full of thoſe awful ſentiments which ſuch a ſingular ſolemnity was calculated to inſpire. But either the fatiguing length of the ceremony, or the impreſſion which this image of death left on his mind, affected him ſo much, that next day he was ſeized with a fever. His feeble frame could not long reſiſt its violence; and he expired on the 21ſt of September, after a life of 58 years 6 months and 21 days.

CHARLES I. } Kings of Britain. See BRITAIN,
CHARLES II. } N° 49——254.

CHARLES XII. king of Sweden, was born in 1682. By his father's will, the adminiſtration was lodged in the hands of the queen dowager Eleonora, with five ſenators, till the young prince was 18: but he was declared major at 15, by the ſtates convened at Stockholm. The beginning of his adminiſtration raiſed no favourable ideas of him, as he was thought both by Swedes and foreigners to be a perſon of mean capacity. But the difficulties that gathered round him, ſoon afforded him an opportunity to diſplay his real character. Three powerful princes, Frederick king of Denmark, Auguſtus king of Poland and elector of Saxony, and Peter the Great czar of Muſcovy, preſuming on his youth, conſpired his ruin almoſt at the ſame inſtant. Their meaſures alarming the council, they were for diverting the ſtorm by negotiations; but Charles, with a grave reſolution that aſtoniſhed them, ſaid, "I am reſolved never to enter upon an unjuſt war, nor to put an end to a juſt one but by the deſtruction of my enemies. My reſolution is fixed: I will attack the firſt who ſhall declare againſt me; and when I have conquered him, I may hope to ſtrike a terror into the reſt." The old counſellors received his orders with admiration; and were ſtill more ſurpriſed when they ſaw him on a ſudden renounce all the enjoyments of a court, reduce his table to the utmoſt frugality, dreſs like a common ſoldier, and, full of the ideas of Alexander and Cæſar, propoſe theſe two conquerors for his models in every thing but their vices. The king of Denmark began by ravaging the territories of the duke of Holſtein. Upon this Charles carried the war into the heart of Denmark, and made ſuch a progreſs that the king of Denmark thought it beſt to accept of peace, which was concluded in 1700. He next reſolved to advance againſt the king of Poland, who had blocked up Riga. He had no ſooner given orders for his troops to go into winter quarters, than he received advice that Narva, where Count Horne was governor, was beſieged by an army of 100,000 Muſcovites. This made him alter his meaſures, and move toward the czar; and at Narva he gained a ſurpriſing victory, which coſt him not above 2000 men killed and wounded. The Muſcovites were forced to retire from the provinces they had invaded. He purſued his conqueſts, till he penetrated as far as where the diet of Poland was ſitting; when he made them declare the throne of Poland vacant, and elect Staniſlaus their king: then making himſelf maſter of Saxony, he obliged Auguſtus himſelf to renounce the crown of Poland, and acknowledge Staniſlaus by a letter of congratulation on his acceſſion. All Europe was ſurpriſed with the expeditious finiſhing of this great negotiation, but more at the diſintereſtedneſs of the king of Sweden, who ſatisfied himſelf with the bare reputation of this victory, without demanding an inch of ground for enlarging his dominions. After thus reducing the king of Denmark to peace, placing a new king on the throne of Poland, having humbled the emperor of Germany, and protected the Lutheran religion, Charles prepared to penetrate into Muſcovy, in order to dethrone the czar. He quickly obliged the Muſcovites to abandon Poland, purſued them into their own country, and won ſeveral battles over them. The czar, diſpoſed to peace, ventured to make ſome propoſals; Charles only anſwered, "I will treat with the czar at Moſcow." When this haughty anſwer was brought to Peter, he ſaid, "My brother Charles ſtill affects to act the Alexander, but I flatter myſelf he will not in me find a Darius." The event juſtified him: for the Muſcovites, already beaten into diſcipline, and under a prince of ſuch talents as Peter, entirely deſtroyed the Swediſh army at the memorable battle of Pultowa, July 8. 1709; on which deciſive day, Charles loſt the fruits of nine years labour, and of almoſt 100 battles! The king, with a ſmall troop, purſued by the Muſcovites, paſſed the Boriſthenes to Oczakow in the Turkiſh territories: and from thence, through deſert countries, arrived at Bender; where the ſultan, when informed of his arrival, ſent orders for accommodating him in the beſt manner, and appointed him a guard. Near Bender Charles built a houſe, and intrenched himſelf; and had with him 1800 men, who were all clothed and fed, with their horſes, at the expence of the grand ſignior. Here he formed a deſign of turning the Ottoman arms upon his enemies; and is ſaid to have had a promiſe from the vizir of being ſent into Muſcovy with 200,000 men. While he remained here, he inſenſibly acquired a taſte for books; he read the tragedies of Corneille and Racine, with the works of Deſpreaux, whoſe ſatires he reliſhed, but did not much admire his other works. When he read that paſſage in which the author repreſents Alexander as a fool and a madman, he tore out the leaf. He would ſometimes play at cheſs: but when he recovered of his wounds, he renewed his fatigues in exerciſing his men: he tired three horſes a-day; and thoſe who courted his favour were all day in their boots. To diſpoſe the Ottoman Porte to this war, he detached about 800 Poles and Coſſacks of his retinue, with orders to paſs the Nieſter, that runs by Bender, and to obſerve what paſſed on the frontiers of Poland. The Muſcovite troops, diſperſed in thoſe quarters, fell immediately upon this little company, and purſued them even to the territories of the grand ſignior. This was what the king expected. His miniſters at the Porte excited the Turks to vengeance; but the czar's money removed all difficulties, and Charles found himſelf in a manner priſoner among the Tartars. He imagined the ſultan was ignorant of the intrigues of his grand vizir. Poniatowſky undertook to make his complaints to the grand ſignior. The ſultan, in anſwer, ſome days after, ſent Charles five Arabian horſes, one of which was covered with a ſaddle and houſing of great richneſs; with an obliging letter, but conceived in ſuch general terms, as gave reaſon to ſuſpect that the miniſter had done nothing without the ſultan's conſent: Charles therefore refuſed them. Poniatowſky had the courage to form a deſign of depoſing the grand vizir, who accordingly was deprived of his dignity and wealth, and baniſhed. The ſeal of the empire was given to Numan Cuproughly; who perſuaded his maſter, that the law forbade him to invade the czar, who had done him no injury; but to ſuccour the king of Sweden as an unfortunate prince in his dominions. He ſent his majeſty 800 purſes, every one of which amounted to 500 crowns, and adviſed him to return peaceably to his own dominions. Charles rejected this advice, threatening to hang up the baſhaws, and ſhave the beards of any janizaries who brought him ſuch meſſages, and ſent word that he ſhould depend upon the grand ſignior's promiſe, and hoped to re-enter Poland as a conqueror with an army of Turks. After various intrigues at the Porte, an order was ſent to attack this *head of iron*, as he was called, and to take him either alive or dead. He ſtood a ſiege in his houſe, with 40 domeſtics, againſt the Turkiſh army; killed no leſs than 20 janizaries with his own hand; and performed prodigies of valour on a very unneceſſary and unwarrantable occaſion. But the houſe being ſet on fire, and himſelf wounded, he was at laſt taken priſoner, and ſent to Adrianople, where the grand ſignior gave him audience, and promiſed to make good all the damages he had ſuſtained. At laſt, after a ſtay of above five years, he left Turkey; and, having diſguiſed himſelf, traverſed Wallachia, Tranſylvania, Hungary, and Germany, attended only by one perſon: and in ſixteen days riding, during which time he never went to bed, came to Stralſund at midnight, November 21. 1714. His boots were cut from his ſwollen legs, and he was put to bed; where, when he had ſlept ſome hours, the firſt thing he did was to review his troops, and examine the ſtate of the fortifications. He ſent out orders that very day to renew the war with more vigour than ever. But affairs were now much changed: Auguſtus had recovered the throne of Poland; Sweden had loſt many of its provinces, and was without money, trade, credit, or troops. The kings of Denmark and Pruſſia ſeized the iſland of Rugen; and beſieged him in Stralſund, which ſurrendered; but Charles eſcaped to Carlſcroon. When his country was threatened with invaſion by ſo many princes, he, to the ſurpriſe of all Europe, marched into Norway with 20,000 men. A very few Danes might have ſtopped the Swediſh army; but ſuch a quick invaſion they could not foreſee. Europe was yet more at a loſs to find the czar ſo quiet, and not making a deſcent upon Sweden, as he had before agreed with his allies. This inaction was the conſequence of one of the greateſt deſigns, and at the ſame time the moſt difficult of any that were ever formed by the imagination of man. In ſhort, a ſcheme was ſet on foot for a reconciliation with the czar; for replacing Staniſlaus on the throne of Poland; and ſetting James II.'s ſon upon that of England, beſides reſtoring the duke of Holſtein to his dominions. Charles was pleaſed with theſe grand ideas, though without building much upon them, and gave his miniſter leave to act at large. In the mean time, Charles was going to make a ſecond attempt upon Norway in 1718; and he flattered himſelf with being maſter of that kingdom in ſix months; but while he was examining the works at Frederickſhall, a place of great ſtrength and importance, which is reckoned to be the key of that kingdom, he was killed by a ſhot from the enemy, as has been generally believed, though it has been alſo reported that he fell by the treachery of one of his own officers, who had been bribed for that purpoſe.

This prince experienced the extremes of proſperity and of adverſity, without being ſoftened by the one or diſturbed for a moment at the other; but was a man rather extraordinary than great, and fitter to be admired than imitated. He was honoured by the Turks for his rigid abſtinence from wine, and his regularity in attending public devotion.

As to his perſon, he was tall and of a noble mein, had a fine open forehead, large blue eyes, flaxen hair, fair complexion, a handſome noſe, but little beard, and a laugh not agreeable. His manners were harſh and auſtere, not to ſay ſavage: and as to religion, he was indifferent towards all, though exteriorly a Lutheran, and a ſtrong believer in predeſtination. A few anecdotes will illuſtrate his character. No dangers, however great, made the leaſt impreſſion upon him. When a horſe or two were killed under him at the battle of Narva, in 1700, he leaped nimbly upon freſh ones, ſaying, "Theſe people find me exerciſe." One day, when he was dictating letters to a ſecretary, a bomb fell through the roof into the next room of the houſe where they were ſitting. The ſecretary, terrified leſt the houſe ſhould come down upon them, let his pen drop out of his hand: "What is the matter?" ſays the king calmly. The ſecretary could only reply, "Ah, Sir, the bomb." "The bomb (ſays the king)! what has the bomb to do with what I am dictating to you! Go on."

He preſerved more humanity than is uſually found among conquerors. Once, in the middle of an action, finding a young Swediſh officer wounded and unable to march, he obliged the officer to take his horſe, and continued to command his infantry on foot. The princeſs Lubomirſki, who was very much in the intereſt and good graces of Auguſtus, falling by accident into the hands of one of his officers, he ordered her to be ſet at liberty: ſaying, "That he did not make war with women." One day, near Leipſic, a peaſant threw himſelf at his feet, with a complaint againſt a grenadier, that he had robbed him of certain eatables provided for himſelf and his family. "Is it true (ſaid Charles ſternly), that you have robbed this man?" The ſoldier replied, "Sir, I have not done near ſo much harm to this man as your majeſty has done to his maſter; for you have taken from Auguſtus a kingdom, whereas I have only taken from this poor ſcoundrel a dinner." Charles made the peaſant amends, and pardoned the ſoldier for his firmneſs: "However, my friend (ſays he to him), you will do well to recollect that if I took a kingdom from Auguſtus, I did not take it for myſelf."

Though Charles lived hardly himſelf, a ſoldier did not fear to remonſtrate to him againſt ſome bread, which was very black and mouldy, and which yet was the only proviſion the troops had. Charles called for a piece of it, and calmly ate it up; ſaying, "that it was indeed not good, but that it might be eaten." From the danger he was in in Poland, when he beat the Saxon troops in 1702, a comedy was exhibited at Marienburg, where the combat was repreſented to the diſadvantage of the Swedes. "Oh, (ſays Charles, hearing of it), I am far from envying them this pleaſure. Let them beat me in the theatres as long as they will, provided I do but beat them in the field." He wrote ſome obſervations on war, and on his own campaigns from 1700 to 1709: but the MS. was loſt at the unfortunate battle of Pultowa.

CHARLES'S CAPE, a promontory of Virginia, in North America, forming the northern headland of the ſtrait that enters the bay of Cheſapeak.

CHARLES's Fort, a fortreſs in the county of Corke, and province of Munſter, in Ireland, ſituated at the mouth of Kinſale harbour. W. Long. 8. 20. N. Lat. 51. 21.

CHARLESTON, the metropolis of South Carolina, is the moſt conſiderable town in the ſtate; ſituated in the diſtrict of the ſame name, and on the tongue of land formed by the confluent ſtreams of Aſhley and Cooper, which are ſhort rivers, but large and navigable. Theſe waters unite immediately below the city, and form a ſpacious and convenient harbour; which communicates with the ocean juſt below Sullivan's iſland; which it leaves on the north, ſeven miles ſouth-eaſt of Charleſton. In theſe rivers the tide riſes, in common, about 6½ feet; but uniformly riſes 10 or 12 inches more during a night tide. The fact is certain; the cauſe unknown. The continual agitation which the tides occaſion in the waters which almoſt ſurround Charleſton, the refreſhing ſea breezes which are regularly felt, and the ſmoke ariſing from ſo many chimneys, render this city more healthy than any part of the low country in the ſouthern ſtates. On this account it is the reſort of great numbers of gentlemen, invalids from the Weſt India iſlands, and of the rich planters from the country, who come here to ſpend the ſickly months, as they are called, in queſt of health and of the ſocial enjoyments which the city affords. And in no part of America are the ſocial bleſſings enjoyed more rationally and liberally than here. Unaffected hoſpitality, affability, eaſe of manners and addreſs, and a diſpoſition to make their gueſts welcome, eaſy, and pleaſed with themſelves, are characteriſtics of the reſpectable people of Charleſton. In ſpeaking of the capital, it ought to be obſerved, for the honour of the people of Carolina in general, that when in common with the other colonies, in the conteſt with Britain, they reſolved againſt the uſe of certain luxuries, and even neceſſaries of life; thoſe articles, which improve the mind, enlarge the underſtanding, and correct the taſte, were excepted; the importation of books was permitted as formerly.

The land on which the town is built, is flat and low, and the water brackiſh and unwholeſome. The ſtreets are pretty regularly cut, and open beautiful proſpects, and have ſubterranean drains to carry off filth and keep the city clean and healthy; but are too narrow for ſo large a place and ſo warm a climate. Their general breadth is from 35 to 66 feet. The houſes which have been lately built, are brick, with tiled roofs. The buildings in general are elegant, and moſt of them are neat, airy, and well furniſhed. The public buildings are, an exchange, a ſtate-houſe, an armoury, a poor-houſe, and an orphan's houſe. Here are ſeveral reſpectable academies. Part of the old barracks has been handſomely fitted up, and converted into a college, and there are a number of ſtudents; but it can only be called as yet a reſpectable academy. Here are two banks, a branch of the national bank, and the South Carolina bank, eſtabliſhed in 1792. The houſes for public worſhip are two Epiſcopal churches, two for Independents, one for Scotch Preſbyterians, one for Baptiſts, one for German Lutherans, two for Methodiſts, one for French Proteſtants, a meeting-houſe for Quakers, a Roman Catholic chapel, and a Jewiſh ſynagogue.

Little attention is paid to the public markets; a great proportion of the moſt wealthy inhabitants having plantations from which they receive ſupplies of almoſt every article of living. The country abounds with poultry and wild ducks. Their beef, mutton and veal are not generally of the beſt kind; and few fiſh are found in the market.

In 1787, it was computed that there were 1600 houſes in this city, and 15,000 inhabitants, including 5400 ſlaves; and what evinces the healthineſs of the place, upwards of 200 of the white inhabitants were above 60 years of age. In 1791, there were 16,359 inhabitants, of whom 7684 were ſlaves. This city has often ſuffered much by fire: the laſt and moſt deſtructive happened as late as June 1796.

Charleſton was incorporated in 1783, and divided into three wards, which chooſe as many wardens, from among whom the citizens elect an intendant of the city. The intendant and wardens form the city-council, who have power to make and enforce bye-laws for the regulation of the city.

The value of exports from this port, in the year ending November 1787, amounted to 505,278l. 19s. 5d. ſterling. The number of veſſels cleared from the cuſtom-houſe the ſame year, was 947, meaſuring 62,118 tons; 735 of theſe, meaſuring 41,531 tons, were American; the others belonged to Great Britain, Ireland, Spain, France, and the United Netherlands.

Charles's Wain, in *Aſtronomy*, ſeven ſtars in the conſtellation called *Urſa Major*, or the Great Bear.

CHARLETON, an iſland at the bottom of Hudſon's bay, in North America, ſubject to Great Britain. W. Long. 80. 0. N. Lat. 53. 30.

Charleton, *Walter*, a learned Engliſh phyſician, born in 1619, was phyſician in ordinary to Charles I. and Charles II. one of the firſt members of the royal ſociety, and preſident of the college of phyſicians. He wrote on various ſubjects; but at laſt his narrow circumſtances obliged him to retire to the iſland of Jerſey, where he died in 1707.

CHARLOCK, the Engliſh name of the Raphanus. It is a very troubleſome weed among corn, being more frequent than almoſt any other. There are two principal kinds of it: the one with a yellow flower, the other with a white. Some fields are particularly ſubject to be overrun with it, eſpecially thoſe which have been manured with cow-dung alone, that being a manure very favourable to the growth of it. The farmers in ſome places are ſo ſenſible of this, that they always mix horſe dung with their cow dung, when they uſe it for arable land. When barley, as is often the caſe, is infeſted with this weed to ſuch a degree as to endanger the crop, it is a very good method to mow down the charlock in May, when it is in flower, cutting it ſo low as juſt to take off the tops of the leaves of barley with it: by this means the barley will get up above the weed: and people have got four quarters of grain from an acre of ſuch land as would have ſcarce yielded any thing without this expedient. Where any land is particularly ſubject to this weed, the beſt method is to ſow it with graſs ſeed, and make a paſture of it; for then the plant will not be troubleſome, it never growing where there is a coat of graſs upon the ground.

Queen CHARLOTTE's *Iſland*, an iſland in the South ſea, firſt diſcovered by Captain Wallis in the Dolphin, in 1767, who took poſſeſſion of it in the name of King George III. Here is good water, and plenty of cocoa nuts, palm nuts, and ſcurvy graſs. The inhabitants are of a middle ſtature, and dark complexion, with long hair hanging over their ſhoulders; the men are well made, and the women handſome; their clothing is a kind of coarſe cloth, or matting, which they faſten about their middle.

Queen Charlotte's Iſlands, a cluſter of South ſea iſlands, diſcovered in 1767 by Captain Carteret. He counted ſeven, and there were ſuppoſed to be many more. The inhabitants of theſe iſlands are deſcribed as extremely nimble and vigorous, and almoſt as well qualified to live in the water as upon land: they are very warlike: and, on a quarrel with ſome of Captain Carteret's people, they attacked them with great reſolution; mortally wounded the maſter and three of the ſailors; were not at all intimidated by the fire arms; and at laſt, notwithſtanding the averſion of Captain Carteret to ſhed blood, he was obliged to ſecure the watering places by firing grape ſhot into the woods, which deſtroyed many of the inhabitants. Theſe iſlands lie in S. Lat. 11° E. Long. 164°. They are ſuppoſed to be the Santa Cruz of Mandana, who died there in 1595.

CHARM, a term derived from the Latin *carmen*, "a verſe;" and uſed to denote a magic power, or ſpell, by which, with the aſſiſtance of the devil, ſorcerers and witches were ſuppoſed to do wonderful things, far ſurpaſſing the power of nature.

CHARNEL, or Charnel-house, a kind of portico, or gallery, uſually in or near a churchyard, over which were anciently laid the bones of the dead, after the fleſh was wholly conſumed. Charnel-houſes are now uſually adjoining to the church.

CHARON, in fabulous hiſtory, the ſon of Erebus and Nox, whoſe office was to ferry the ſouls of the deceaſed over the waters of Acheron, for which each ſoul was to pay a piece of money. For this reaſon the Pagans had a cuſtom of putting a piece of money into the mouth of the dead, in order that they might have ſomething to pay Charon for their paſſage.

CHARONDAS, a celebrated legiſlator of the Thurians, and a native of Catanea, in Sicily, flouriſhed 446 before Chriſt. He forbade any perſon's appearing armed in the public aſſemblies of the nation; but one day going thither in haſte, without thinking of his ſword, he was no ſooner made to obſerve his miſtake than he ran it through his body.

CHAROST, a town of France, in Berry, with the title of a duchy. It is ſeated on the river Arnon. E. Long. 2. 15. N. Lat. 46. 56.

CHAROUX, a town of France, in the Bourbonnois, ſeated on an eminence, near the river Sioulle. It has two pariſhes, which are in different dioceſes. E. Long. 3. 15. N. Lat. 46. 10.

CHARPENTIER, Francis, dean of the French academy, was born in 1620. His early capacity inclined his friends to educate him at the bar: but he was much more delighted with the ſtudy of languages and antiquity than of the law; and preferred repoſe to tumult. M. Colbert made uſe of him in eſtabliſhing his new academy of medals and inſcriptions; and no perſon of that learned ſociety contributed more than himſelf toward that noble ſeries of medals which were ſtruck on the conſiderable events that diſtinguiſhed the reign of Louis XIV. He publiſhed ſeveral works, which were all well received; and died in 1702.

CHARR. See SALMO, ICHTHYOLOGY *Index*.

CHARRON, PETER, the author of a book entitled *Of Wiſdom*, which gained him great reputation, was born at Paris in the year 1541. After being advocate in the parliament of Paris for five or ſix years, he applied himſelf to divinity; and became ſo great a preacher, that the biſhops of ſeveral dioceſes offered him the higheſt dignities in their gift. He died at Paris, ſuddenly in the ſtreet, November 16. 1603.

CHART, or SEA CHART, an hydrographical map, or a projection of ſome part of the earth's ſuperficies *in plano*, for the uſe of navigators.

Charts differ very conſiderably from geographical or land maps, which are of no uſe in navigation. Nor are ſea charts all of the ſame kind, ſome being what we call plane charts, others Mercator charts, and others globular charts.

Plane CHART, is a repreſentation of ſome part of the ſuperficies of the terraqueous globe, in which the meridians are ſuppoſed parallel to each other, the parallels of latitude at equal diſtances, and conſequently the degrees of latitude and longitude everywhere equal to each other. See *PLANE Chart*.

Mercator's CHART, is that where the meridians are ſtraight lines, parallel to each other, and equidiſtant; the parallels are alſo ſtraight lines, and parallel to each other; but the diſtance between them increaſes from the equinoctial towards either pole, in the ratio of the ſecant of the latitude to the radius. See NAVIGATION.

Globular CHART, a meridional projection, wherein the diſtance of the eye from the plane of the meridian, upon which the projection is made, is ſuppoſed to be equal to the ſine of the angle 45°. This projection comes the neareſt of all to the nature of the globe, becauſe the meridians therein are placed at equal diſtances; the parallels alſo are nearly equidiſtant, and conſequently the ſeveral parts of the earth have their proper proportion of magnitude, diſtance, and ſituation, nearly the ſame as on the globe itſelf. See *GLOBULAR Projection*.

Hydrographic CHARTS, ſheets of large paper, whereon ſeveral parts of the land and ſea are deſcribed, with their reſpective coaſts, harbours, ſounds, flats, rocks, ſhelves, ſands, &c. together with the longitude and latitude of each place, and the points of the compaſs. See *MERCATOR's Chart*.

Selenographic CHARTS, particular deſcriptions of the ſpots, appearances, and maculæ of the moon. See ASTRONOMY *Index*.

Topographic CHARTS, draughts of ſome ſmall parts of the earth only, or of ſome particular place, without regard to its relative ſituation, as London, York, &c.

CHARTA, or CARTA, primarily ſignifies a ſort of paper made of the plant *papyrus* or *biblus*. See PAPER and CHARTER.

CHARTA *Emporetica*, in *Pharmacy*, &c. a kind of paper made very ſoft and porous, uſed to filter withal. See FILTRATION, &c.

CHARTA is alſo uſed in our ancient cuſtoms for a charter, or deed in writing. See CHARTER.

Magna CHARTA, the great charter of the liberties of Britain, and the baſis of our laws and privileges.

This charter may be ſaid to derive its origin from King Edward the Confeſſor, who granted ſeveral privileges to the church and ſtate by charter: theſe liberties and privileges were alſo granted and confirmed by King Henry I. by a celebrated great charter now loſt; but which was confirmed or re-enacted by King Henry II. and King John. Henry III. the ſucceſſor of this laſt prince, after having cauſed 12 men make inquiry into the liberties of England in the reign of Henry I. granted a new charter; which was the ſame as the preſent magna charta. This he ſeveral times confirmed, and as often broke; till, in the 37th year of his reign, he went to Weſtminſter Hall, and there, in preſence of the nobility and biſhops, who held lighted candles in their hands, magna charta was read, the king all the time holding his hand to his breaſt, and at laſt ſolemnly ſwearing faithfully and inviolably to obſerve all the things therein contained, &c. Then the biſhops extinguiſhing the candles, and throwing them on the ground, they all cried out, "Thus let him be extinguiſhed, and ſtink in hell, who violates this charter." It is obſerved, that, notwithſtanding the ſolemnity of this confirmation, King Henry, the very next year, again invaded the rights of his people, till the barons entered into a war againſt him; when, after various ſucceſs, he confirmed this charter, and the charter of the foreſt, in the 52d year of his reign.

This charter confirmed many liberties of the church, and redreſſed many grievances incident to feodal tenures, of no ſmall moment at the time; though now, unleſs conſidered attentively and with this retroſpect, they ſeem but of trifling concern. But, beſides theſe feodal proviſions, care was alſo taken therein to protect the ſubject againſt other oppreſſions, then frequently ariſing from unreaſonable amercements, from illegal diſtreſſes or other proceſs for debts or ſervices due to the crown, and from the tyrannical abuſe of the prerogative of purveyance and pre-emption. It fixed the forfeiture of lands for felony in the ſame manner as it ſtill remains; prohibited for the future the grants of excluſive fiſheries; and the erection of new bridges ſo as to oppreſs the neighbourhood. With reſpect to private rights, it eſtabliſhed the teſtamentary power of the ſubject over part of his perſonal eſtate, the reſt being diſtributed among his wife and children; it laid down the law of dower, as it hath continued ever ſince; and prohibited the appeals of women, unleſs after the death of their huſbands. In matters of public police and national concern, it enjoined an uniformity of weights and meaſures; gave new encouragements to commerce, by the protection of merchant ſtrangers; and forbade the alienation of lands in mortmain. With regard to the adminiſtration of juſtice; beſides prohibiting all denials or delays of it, it fixed the court of common pleas at Weſtminſter, that the ſuitors might no longer be haraſſed with following the king's perſon in all his progreſſes; and at the ſame time brought the trial of iſſues home to the very doors of the freeholders, by directing aſſizes to be taken in the proper counties, and eſtabliſhing annual circuits: it alſo corrected ſome abuſes then incident to the trials by wager of law and of battle; directed the regular awarding

ing of inqueſts for life or member; prohibited the king's inferior miniſters from holding pleas of the crown, or trying any criminal charge, whereby many forfeitures might otherwiſe have unjuſtly accrued to the exchequer; and regulated the time and place of holding the inferior tribunals of juſtice, the county-court, ſheriff's torn, and court-leet. It confirmed and eſtabliſhed the liberties of the city of London, and all other cities, boroughs, towns, and ports of the kingdom. And laſtly (which alone would have merited the title that it bears, of the *great charter*), it protected every individual of the nation in the free enjoyment of his life, his liberty, and his property, unleſs declared to be forfeited by the judgment of his peers, or the law of the land.

This excellent charter, ſo equitable, and beneficial to the ſubject, is the moſt ancient written law in the kingdom. By the 25th Edward I. it is ordained, that it ſhall be taken as the common law; and by the 43d Edward III. all ſtatutes made againſt it are declared to be void.

CHARTER, in *Law*, a written inſtrument, or evidence of things acted between one perſon and another. The word charter comes from the Latin *charta*, anciently uſed for a public and authentic act, a donation, contract, or the like; from the Greek χαρτης, "thick paper" or "paſteboard," whereon public acts were wont to be written. Britton divides charters into thoſe of the king, and thoſe of private perſons. 1. Charters of the king, are thoſe whereby the king paſſeth any grant to any perſon or body politic, as a *charter of exemption*, of privilege, &c. *charter of pardon*, whereby a man is forgiven a felony, or other offence committed againſt the king's crown and dignity; *charter of the foreſt*, wherein the laws of the foreſt are compriſed, ſuch as the charter of Canutus, &c. 2. Charters of private perſons, are deeds and inſtruments for the conveyance of lands, &c. And the purchaſer of lands ſhall have all the charters, deeds, and evidences, as incident to the ſame, and for the maintenance of his title.

Charter-Governments in America. See Colony.

Charter-Land, ſuch land as a perſon holds by charter; that is, by evidence in writing; otherwiſe called *freehold*.

CHARTERPARTY, in commerce, denotes the inſtrument of freightage, or articles of agreement for the hire of a veſſel. See Freight, &c.

The charterparty is to be in writing; and to be ſigned both by the proprietor or the maſter of the ſhip, and the merchant who freights it. It is to contain the name and the burden of the veſſel; the names of the maſter and the freighter; the price or rate of freight; and the time of loading and unloading: and the other conditions agreed on. It is properly a deed, or policy, whereby the maſter or proprietor of the veſſel engages to furniſh immediately a tight ſound veſſel, well equipped, caulked, and ſtopped, provided with anchors, ſails, cordage, and all other furniture to make the voyage required, as equipage, hands, victuals, and other munitions; in conſideration of a certain ſum to be paid by the merchant for the freight. Laſtly, The ſhip with all its furniture, and the cargo, are reſpectively ſubjected to the conditions of the *charterparty*. The *charterparty* differs from a *bill of lading*, in that the firſt is for the entire freight, or lading, and that both for going and returning; whereas the latter is only for a part of the freight, or at moſt only for the voyage one way.

Boyer ſays, the word is derived from hence, that *per medium charta incidebatur, et ſic fiebat charta partita;* becauſe, in the time when notaries were leſs common, there was only one inſtrument made for both parties: this they cut in two, and gave each his portion; joining them together at their return, to know if each had done his part. This he obſerves to have been practiſed in his time; agreeable to the method of the Romans, who, in their ſtipulations, uſed to break a ſtaff, each party retaining a moiety thereof as a mark.

CHARTOPHYLAX, the name of an officer of the church of Conſtantinople, who attends at the door of the rails when the ſacrament is adminiſtered, and gives notice to the prieſts to come to the holy table. He repreſents the patriarch upon the bench, tries all eccleſiaſtical cauſes, keeps all the marriage regiſters, aſſiſts at the conſecration of biſhops, and preſents the biſhop elect at the ſolemnity, and likewiſe all other ſubordinate clergy. This office reſembles in ſome ſhape that of the *bibliothecarius* at Rome.

CHARTRES, a large city of France, in the province of Orleannois, ſituated on the river Eure, in E. Long. 1. 32. N. Lat. 48. 47. It is a biſhop's ſee.

CHARTREUSE, or Chartreuse-grand, a celebrated monaſtery, the capital of all the convents of the Carthuſian monks, ſituated on a ſteep rock in the middle of a large foreſt of fir trees, about ſeven miles north-eaſt of Grenoble, in the province of Dauphiny in France. E. Long. 5. 5. N. Lat. 45. 20. See Carthusians.

From this mother convent, all the others of the ſame order took their name; among which was the Chartreuſe of London, corruptly called the *charterhouſe*, now converted into an hoſpital, and endowed with a revenue of 600l. per annum.

Here were maintained 80 decayed gentlemen, not under 50 years of age; alſo 40 boys are educated and fitted either for the univerſity or trades. Thoſe ſent to the univerſity have an exhibition of 20l. a-year for eight years: and have an immediate title to nine church-livings in the gift of the governors of the hoſpital, who are ſixteen in number, all perſons of the firſt diſtinction, and take their turns in the nomination of penſioners and ſcholars.

CHARTULARY, Chartularius, a title given to an ancient officer in the Latin church, who had the care of charters and papers relating to public affairs. The chartulary preſided in eccleſiaſtical judgments, in lieu of the pope. In the Greek church the chartulary was called *chartophylax;* but his office was there much more conſiderable; and ſome even diſtinguiſh the chartulary from the chartophylax in the Greek church. See Chartophylax.

CHARYBDIS, in *Ancient Geography*, a whirlpool in the ſtraits of Meſſina, according to the poets; near Sicily, and oppoſite to Scylla, a rock on the coaſt of Italy. Thucydides makes it to be only a ſtrong flux and reflux in the ſtrait, or a violent reciprocation of the tide, eſpecially if the wind ſets ſouth. But on diving into the Charybdis, there are found vaſt gulfs and whirlpools below, which produce all the commotion on the ſurface of the water.

Charybdis is uſed by Horace to denote a rapacious proſtitute.

CHASE, or CHACE, in *Law*, is uſed for a driving of cattle to or from any place; as to a diſtreſs, or fortlet, &c.

CHASE, or *Chace* is alſo a place of retreat for deer and wild beaſts; of a middle kind between a foreſt and a park, being uſually leſs than a foreſt, and not poſſeſſed of ſo many privileges; but wanting, v. g. courts of attachment, ſwainmote, and juſtice ſeat *. Yet it is of a large extent, and ſtocked both with a greater diverſity of wild beaſts or game, and more keepers than a park. Crompton obſerves, that a foreſt cannot be in the hands of a ſubject, but it forthwith loſes its name, and becomes a *chaſe;* in regard all thoſe courts loſe their nature when they come into the hands of a ſubject; and that none but a king can make a lord chief juſtice in eyre of the foreſt. See JUSTICE *in Eyre*.

* See *Foreſt*

Britiſh Zool. i. 42.

The following hiſtory of the Engliſh chaſe is given by Mr Pennant. "At firſt the beaſts of chaſe had this whole iſland for their range; they knew no other limits than the ocean, nor confeſſed any particular maſter. When the Saxons had eſtabliſhed themſelves in the heptarchy, they were reſerved by each ſovereign for his own particular diverſion. Hunting and war, in thoſe uncivilized ages, were the only employ of the great; their active, but uncultivated minds, being ſuſceptible of no pleaſures but thoſe of a violent kind, ſuch as gave exerciſe to their bodies, and prevented the pain of thinking.

"But as the Saxon kings only appropriated thoſe lands to the uſe of foreſts which were unoccupied, ſo no individuals received any injury; but when the Conqueſt had ſettled the Norman line on the throne, this paſſion for the chaſe was carried to an exceſs, which involved every civil right in a general ruin: it ſuperſeded the conſideration of religion even in a ſuperſtitious age: the village communities, nay even the moſt ſacred edifices, were turned into one vaſt waſte, to make room for animals, the objects of a lawleſs tyrant's pleaſure. The new foreſt in Hampſhire is too trite an inſtance to be dwelt on; ſanguinary laws were enacted to preſerve the game; and in the reigns of William Rufus, and Henry I. it was leſs criminal to deſtroy one of the human ſpecies than a beaſt of chaſe. Thus it continued while the Norman line filled the throne; but when the Saxon line was reſtored under Henry II. the rigour of the foreſt laws was immediately ſoftened.

"When our barons began to form a power, they claimed a vaſt, but more limited, tract for a diverſion that the Engliſh were always fond of. They were very jealous of any encroachments on their reſpective bounds, which were often the cauſe of deadly feuds; ſuch a one gave cauſe to the fatal battle of *Chevy-chaſe;* a fact which, though recorded only in a ballad, may, from what we know of the manners of the times, be founded on truth; not that it was attended with all the circumſtances which the author of that natural but heroic compoſition hath given it; for, on that day neither a *Percy* nor a *Douglas* fell: here the poet ſeems to have claimed his privilege, and mixed with this fray ſome of the events of the battle of *Otterbourne*.

"When property became happily more divided by the relaxation of the feodal tenures, theſe extenſive hunting grounds became more limited; and as tillage and huſbandry increaſed, the beaſts of chaſe were obliged to give way to others more uſeful to the community. The vaſt tracts of land, before dedicated to hunting, were then contracted; and, in proportion as the uſeful arts gained ground, either loſt their original deſtination, or gave riſe to the invention of *parks*. Liberty and the arts ſeem coeval; for when once the latter got footing, the former protected the labours of the induſtrious from being ruined by the licentious ſportſman, or being devoured by the objects of his diverſion: for this reaſon, the ſubjects of a deſpotic government ſtill experience the inconveniences of vaſt waſtes and foreſts, the terrors of the neighbouring huſbandmen; while in our well regulated monarchy very few chaſes remain. The Engliſh ſtill indulge themſelves in the pleaſures of hunting; but confine the deer kind to parks, of which England boaſts of more than any other kingdom in Europe. The laws allow every man his pleaſure; but confine them in ſuch bounds as prevent them from being injurious to the meaneſt of the community. Before the Reformation, the prelates ſeem to have guarded ſufficiently againſt this want of amuſement, the ſee of Norwich, in particular, being poſſeſſed, about that time, of thirteen parks."

CHASE, in the ſea language, is to purſue a ſhip; which is alſo called *giving chaſe*.

*Stern-*CHACE, is when the chaſer follows the chaſed aſtern directly upon the ſame point of the compaſs.

To lie with a ſhip's fore-foot in a CHASE, is to ſail and meet with her by the neareſt diſtance; and ſo to croſs her in her way, or to come acroſs her fore-foot.

A ſhip is ſaid to have a *good chaſe*, when ſhe is ſo built forward on, or a-ſtern, that ſhe can carry many guns to ſhoot forwards or backwards; according to which ſhe is ſaid to have a *good forward* or *good ſtern chaſe*.

CHASE *Guns*, are ſuch whoſe ports are either in the head (and then they are uſed in chaſing of others); or in the ſtern, which are only uſeful when they are purſued or chaſed by any other ſhip.

CHACE *of a Gun*, is the whole bore or length of a piece taken withinſide.

Wild-gooſe CHACE, a term uſed to expreſs a ſort of racing on horſeback uſed formerly, which reſembled the flying of wild geeſe; thoſe birds generally going in a train one after another, not in confuſed flocks as other birds do. In this ſort of race the two horſes, after running twelve ſcore yards, had liberty, which horſe ſoever could take the leading, to ride what ground the jockey pleaſed, the hindmoſt horſe being bound to follow him within a certain diſtance agreed on by the articles, or elſe to be whipped in by the tryers and judges who rode by; and whichever horſe could diſtance the other won the race. This ſort of racing was not long in common uſe; for it was found inhuman, and deſtructive to good horſes, when two ſuch were matched together. For in this caſe neither was able to diſtance the other till they were both ready to ſink under their riders; and often two very good horſes were both ſpoiled, and the wagers forced to be drawn at laſt. The miſchief of this ſort of racing ſoon brought in the method now in uſe, of running only for a certain quantity of ground, and determining the plate or wager by the coming in firſt at the poſt.

Chasing of Gold, Silver, &c. See Enchasing.

CHASTE tree. See Vitex, Botany *Index*.

CHASTITY; Purity of the body, or freedom from obſcenity.—The Roman law juſtifies homicide in defence of the chaſtity either of one's ſelf or relations; and ſo alſo, according to Selden, ſtood the law in the Jewiſh republic. Our law likewiſe juſtifies a woman for killing a man who attempts to raviſh her. So the huſband or father may juſtify killing a man who attempts a rape upon his wife or daughter; but not if he takes them in adultery by conſent; for the one is forcible and felonious, but not the other.

Chaſtity is a virtue univerſally celebrated. There is indeed no charm in the female ſex that can ſupply its place. Without it, beauty is unlovely, and rank is contemptible; good breeding degenerates into wantonneſs, and wit into impudence. Out of the numerous inſtances of eminent chaſtity recorded by authors, the two following are ſelected on account of the leſſon afforded by the different modes of conduct which they exhibit.

Lucretia was a lady of great beauty and noble extraction; ſhe married Collatinus, a relation of Tarquinius Superbus king of Rome. During the ſiege of Ardea, which laſted much longer than was expected, the young princes paſſed their time in entertainments and diverſions. One day as they were at ſupper *, at Sextus Tarquin's the king's eldeſt ſon, with Collatinus, Lucretia's huſband, the converſation turned on the merit of their wives: every one gave his own the preference. "What ſignify ſo many words?" ſays Collatinus; "you may in a few hours, if you pleaſe, be convinced by your own eyes, how much my Lucretia excels the reſt. We are young: let us mount our horſes, and go and ſurpriſe them. Nothing can better decide our diſpute than the ſtate we ſhall find them in at a time, when moſt certainly they will not expect us." They were a little warmed with wine: "Come on, let us go," they all cried together. They quickly galloped to Rome, which was about twenty miles from Ardea, where they find the princeſſes, wives of the young Tarquins, ſurrounded with company, and every circumſtance of the higheſt mirth and pleaſure. From thence they rode to Collatia, where they ſaw Lucretia in a very different ſituation. With her maids about her, ſhe was at work in the inner part of her houſe, talking on the dangers to which her huſband was expoſed. The victory was adjudged to her unanimouſly. She received her gueſts with all poſſible politeneſs and civility. Lucretia's virtue, which ſhould have commanded reſpect, was the very thing which kindled in the breaſt of Sextus Tarquin a ſtrong and deteſtable paſſion. Within a few days he returned to Collatia; and upon the plauſible excuſe he made for his viſit, he was received with all the politeneſs due to a near relation, and the eldeſt ſon of a king. Watching the fitteſt opportunity; he declares the paſſion ſhe had excited at his laſt viſit, and employed the moſt tender entreaties, and all the artifices poſſible to touch a woman's heart; but all to no purpoſe. He then endeavoured to extort her compliance by the moſt terrible threatenings. It was in vain. She ſtill perſiſted in her reſolution; nor could ſhe be moved even by the fear of death. But when the monſter told her that he would firſt diſpatch her, and then having murdered a ſlave, would lay him by her ſide, after which he would ſpread a report, that having caught them in the act of adultery, he had puniſhed them as they deſerved; this ſeemed to ſhake her reſolution. She heſitated, not knowing which of theſe dreadful alternatives to take, whether, by conſenting to diſhonour the bed of her huſband, whom ſhe tenderly loved; or by refuſing, to die under the odious character of having proſtituted her perſon to the luſt of a ſlave. He ſaw the ſtruggle of her ſoul; and ſeizing the unlucky moment, obtained an inglorious conqueſt. Thus, Lucretia's virtue, which had been proof againſt the fear of death, could not hold out againſt the fear of infamy. The young prince, having gratified his paſſion, returned home as in triumph. On the morrow, Lucretia overwhelmed with grief and deſpair, ſent early in the morning to deſire her father and her huſband to come to her and bring with them each a truſty friend, aſſuring them there was no time to loſe. They came with all ſpeed, the one accompanied with Valerius (ſo famous after under the name of Publicola), and the other with Brutus. The moment ſhe ſaw them come, ſhe could not command her tears; and when her huſband aſked her if all was well? "By no means," ſaid ſhe, "it cannot be well with a woman after ſhe has loſt her honour. Yes, Collatinus, thy bed has been defiled by a ſtranger: but my body only is polluted: my mind is innocent, as my death ſhall witneſs. Promiſe me only not to ſuffer the adulterer to go unpuniſhed: it is Sextus Tarquinius, who laſt night, a treacherous gueſt, or rather cruel foe, offered me violence, and reaped a joy fatal to me; but, if you are men, it will be ſtill more fatal to him." All promiſed to revenge her; and at the ſame time, tried to comfort her with repreſenting, "That the mind only ſins, not the body; and where the conſent is wanting, there can be no guilt." "What Sextus deſerves," replies Lucretia, "I leave you to judge; but for me, though I declare myſelf innocent of the crime, I exempt not myſelf from puniſhment. No immodeſt woman ſhall plead Lucretia's example to outlive her diſhonour." Thus ſaying, ſhe plunged into her breaſt a dagger ſhe had concealed under her robe, and expired at their feet. Lucretia's tragical death has been praiſed and extolled by Pagan writers, as the higheſt and moſt noble act of heroiſm. The Goſpel thinks not ſo: it is murder, even according to Lucretia's own principles, ſince ſhe puniſhed with death an innocent perſon, at leaſt acknowledged as ſuch by herſelf. She was ignorant that our life is not in our own power, but in his diſpoſal from whom we receive it. St Auſtin, who carefully examines, in his book *De Civitate Dei*, what we are to think of Lucretia's death, conſiders it not as a courageous action flowing from a true love of chaſtity, but as an infirmity of a woman too ſenſible of worldly fame and glory; and who, from a dread of appearing in the eyes of men an accomplice of the violence ſhe abhorred, and of a crime to which ſhe was entirely a ſtranger, commits a real crime upon herſelf voluntarily and deſignedly. But what cannot be ſufficiently admired in this Roman lady, is her abhorrence of adultery, which ſhe ſeems to hold ſo deteſtable as not to bear the thoughts of it. In this ſenſe, ſhe is a noble example for all her ſex.

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* *Liv.* l. i. c. 56—60 *Dionyſ.* iv. p. 26.—277. *Flor.* l. iii 9.

Chiomara, the wife of Ortiagon, a Gauliſh prince, was equally admirable for her beauty and chaſtity.

During the war between the Romans and the Gauls, A. R. 563, the latter were totally defeated on Mount Olympus. Chiomara, among many other ladies, was taken priſoner, and committed to the care of a centurion, no leſs paſſionate for money than women. He at firſt endeavoured to gain her conſent to his infamous deſires; but not being able to prevail upon her, and ſubvert her conſtancy, he thought he might employ force with a woman whom misfortune had reduced to ſlavery. Afterwards, to make her amends for that treatment, he offered to reſtore her liberty: but not without ranſom. He agreed with her for a certain ſum, and to conceal this deſign from the other Romans, he permitted her to ſend any of the priſoners ſhe ſhould chooſe to her relations, and aſſigned a place near the river where the lady ſhould be exchanged for gold. By accident there was one of her own ſlaves among the priſoners. Upon him ſhe fixed; and the centurion ſoon after carried her beyond the advanced poſts, under cover of a dark night. The next evening two of the relations of the princeſs came to the place appointed, whither the centurion alſo carried his captive. When they had delivered him the Attic talent they had brought, which was the ſum they had agreed on, the lady, in her own language, ordered thoſe who came to receive her to draw their ſwords and kill the centurion, who was then amuſing himſelf with weighing the gold. Then, charmed with having revenged the injury done her chaſtity, ſhe took the head of the officer, which ſhe had cut off with her own hands, and hiding it under her robe, went to her huſband Ortiagon, who had returned home after the defeat of his troops. As ſoon as ſhe came into his preſence, ſhe threw the centurion's head at his feet. He was ſtrangely ſurpriſed at ſuch a ſight: and aſked her whoſe head it was, and what had induced her to do an act ſo uncommon to her ſex? With her face covered with a ſudden bluſh, and at the ſame time expreſſing her fierce indignation, ſhe declared the outrage which had been done her, and the revenge ſhe had taken for it. During the reſt of her life, ſhe ſtedfaſtly retained the ſame attachment for the purity of manners which conſtitutes the principal glory of the ſex, and nobly ſuſtained the honour of ſo glorious, bold, and heroic an action.—This lady was much more prudent than Lucretia, in revenging her injured honour by the death of her raviſher, rather than by her own. Plutarch relates this fact, in his treatiſe upon the virtue and great actions of women; and it is from him we have the name of this, which is well worthy of being tranſmitted to poſterity.

The above virtue in men is termed *continence*. See Continence.

CHATEAU-briant, a town of France in Britanny, with an old caſtle. W. Long. 1. 20. N. Lat. 47. 40.

Chateau-Chinon, a town of France in Nivernois, and capital of Morvant, with a conſiderable manufacture of cloth. E. Long. 3. 48. N. Lat. 47. 2.

Chateau-Dauphin, a very ſtrong caſtle of Piedmont in Italy, and in the marquiſate of Saluces, belonging to the king of Sardinia. It was taken by the combined army of France and Spain in 1744, and was reſtored by the treaty of Aix-la-Chapelle.

Chateau-du-Loire, a town of France, in Maine, famous for ſuſtaining a ſiege of ſeven years againſt the Count of Mans. It is ſeated on the river Loire, in E. Long. 0. 25. N. Lat. 47. 40.

Chateau-Dun, an ancient town of France, and capital of the Dunois, with a caſtle and rich monaſtery; ſeated on an eminence near the river Loire, in E. Long. 1. 26. N. Lat. 48. 4.

Chateau-Neuf, the name of ſeveral towns of France, viz. one in Perche; another in Angumois, on the river Charente, near Angouleſme; a third in Berry, ſeated on the river Cher; and ſeveral other ſmall places.

Chateau-Portien, a town of France, in Champagne, and in a diſtrict called Portien, with a caſtle built on a rock, near the river Aiſne. E. Long. 4. 23. N. Lat. 49. 35.

Chateau-Renaud, a town of France, in the Gatenois, where clothes are made for the army, and where there is a trade in ſaffron. E. Long. 4. 25. N. Lat. 48. 0. This is alſo the name of a town of Touraine, in France, with the title of marquiſate. E. Long. 2. 41. N. Lat. 47. 22.

Chateau-Roux, a town of France, in Berry, with the title of a duchy. It has a cloth manufacture, and is ſeated in a very large pleaſant plain on the river Indre, in E. Long. 1. 47. N. Lat. 46. 49.

Chateau-Thiery, a town of France, in Champagne, with the title of a duchy, and a handſome caſtle on an eminence, ſeated on the river Maine, in E. Long. 3. 23. N. Lat. 49. 12.

Chateau-Vilain, a town of France, in Champagne, with a caſtle, and the title of a duchy; ſeated on the river Anjou. E. Long. 2. 59. N. Lat. 48. 0.

CHATEL, or Chate, a town of Lorraine, in the Voſque, ſeated on the river Moſelle, eight miles from Mirecourt.

Chatel-Allon, a maritime town of France, in Saintonge, five miles from Rochelle; formerly very conſiderable, but now greatly decayed.

Chatel-Chalon, a town of France, in Franche Comte, remarkable for its abbey of Benedictine nuns. E. Long. 5. 25. N. Lat. 46. 50.

CHATELET, a town of the Netherlands, in Namur, ſeated on the Sambre, in the biſhopric of Liege. E. Long. 4. 28. N. Lat. 50. 25.

Chatelet, the name of certain courts of juſtice eſtabliſhed in ſeveral cities in France. The grand chatelet at Paris is the place where the preſidial or ordinary court of juſtice of the provoſt of Paris is kept; conſiſting of a preſidial, a civil chamber, a criminal chamber, and a chamber of policy. The little chatelet is an old fort, now ſerving as a priſon.

CHATELLERAULT, a town of France, in Poitou, with the title of a duchy; ſeated in a fertile and pleaſant country, on the river Vienne, over which there is a handſome ſtone bridge. E. Long. 0. 40. N. Lat. 46. 34.

CHATHAM, a town of Kent, adjoining to Rocheſter, and ſeated on the river Medway. It is the principal ſtation of the royal navy; and the yards and magazines are furniſhed with all kinds of naval ſtores, as well as materials for building and rigging the largeſt men of war. The entrance into the river Medway is defended by Sheerneſs and other forts; notwithſtanding which, the Dutch fleet burnt ſeveral ſhips of war here in the reign of Charles II. after the peace of Breda had been agreed upon. In the year 1757, by direction of the duke of Cumberland, ſeveral additional fortifications were begun at Chatham; ſo that now the ſhips are in no danger of an inſult either by land or water. It has a church, a chapel of eaſe, and a ſhip uſed as a church for the ſailors. It has likewiſe about 500 houſes, moſtly low, and built with brick; the ſtreets are narrow, and paved; and it contains about 3000 inhabitants. The principal employment of the labouring hands is ſhip-building in the king's yard and private docks. This town gave title of earl to that great ſtateſman William Pitt in the reigns of George II. and III. E. Long. 0. 40. N. Lat. 51. 20.

CHATIGAN, a town of Aſia, in the kingdom of Bengal, on the moſt eaſterly branch of the river Ganges. It is but a poor place, though it was the firſt the Portugueſe ſettled at in theſe parts, and who ſtill keep a ſort of poſſeſſion. It has but a few cotton manufactures; but affords the beſt timber for building of any place about it. The inhabitants are ſo ſuſpicious of each other, that they always go armed with a ſword, piſtol, and blunderbuſs, not excepting the prieſts. It is ſubject to the Great Mogul. E. Long. 91. 10. N. Lat. 23. 0.

CHATILLON ſur Seine, a town of France, in Burgundy, divided into two by the river Seine. It is 32 miles from Langres, and 40 from Dijon; and has iron works in its neighbourhood. E. Long. 4. 33. N. Lat. 47. 45.

CHATRE, a town of France, in Berry, ſeated on the river Indre, 37 miles from Bourges. It carries on a conſiderable trade in cattle. E. Long. 1. 55. N. Lat. 46. 35.

CHATTELS, a Norman term, under which were anciently comprehended all moveable goods; thoſe immoveable being termed *fief* or *fee*.

Chattels, in the modern ſenſe of the word, are all ſorts of goods, moveable or immoveable, except ſuch as are in the nature of freehold.

CHATTERER. See Ampelis, Ornithology *Index*.

CHATTERTON, Thomas, a late unfortunate poet, whoſe fate and performances have excited in no ſmall degree the public attention, as well as given riſe to much literary controverſy. He was born at Briſtol, Nov. 20. 1752; and educated at a charity ſchool on St Auguſtine's Back, where nothing more was taught than reading, writing, and accounts. At 14 years of age, he was articled clerk to an attorney at Briſtol, with whom he continued about three years; yet, though his education was thus confined, he diſcovered an early turn towards poetry and Engliſh antiquities, and particularly towards heraldry. How ſoon he began to be an author is not known. In the Town and Country Magazine for March 1769, are two letters, probably from him, as they are dated from Briſtol, and ſubſcribed with his uſual ſignature, D. B. that is, *Dunhelmus Briſtolienſis*. The former contains ſhort extracts from two MSS. "written 300 years ago by one Rowley a monk," concerning dreſs in the age of Henry II.; the latter, "Ethelgar, a Saxon poem," in bombaſt proſe. In the ſame magazine for May 1769, are three communications from Briſtol, with the ſame ſignature D. B. one of them entitled, "Obſervations upon Saxon Heraldry, with drawings of Saxon Achievements;" and in the ſubſequent months of 1769 and 1770, there are ſeveral other pieces in the ſame magazine, which are undoubtedly of his compoſition.

In April 1770, he left Briſtol, diſguſted with his profeſſion, and irreconcileable to the line of life in which he was placed; and coming to London in hopes of advancing his fortune by his pen, he ſunk at once from the ſublimity of his views to an abſolute dependence on the patronage of bookſellers. Things, however, ſeem ſoon to have brightened up a little with him; for, May 14. he writes to his mother, in high ſpirits, upon the change of his ſituation, with the following ſarcaſtic reflections upon his former patrons at Briſtol. "As to Mr ——, Mr ——, Mr ——, &c. &c. they rate literary lumber ſo low, that I believe an author, in their eſtimation, muſt be poor indeed: but here matters are otherwiſe. Had Rowley been a Londoner inſtead of a Briſtowyan, I could have lived by copying his works." In a letter to his ſiſter, May 30. he informs her that he is to be employed in writing a voluminous Hiſtory of London, to appear in numbers the beginning of next winter. Meanwhile, he had written ſomething in praiſe of Beckford, then lord mayor, which had procured him the honour of being preſented to his lordſhip; and, in the letter juſt mentioned, he gives the following account of his reception, with certain obſervations upon political writing. "The lord mayor received me as politely as a citizen could: but the devil of the matter is, there is no money to be got on this ſide of the queſtion.—However, he is a poor author who cannot write on both ſides.—Eſſays on the patriotic ſide will fetch no more than what the copy is ſold for. As the patriots themſelves are ſearching for places, they have no gratuity to ſpare.—On the other hand, unpopular eſſays will not even be accepted, and you muſt pay to have them printed; but then you ſeldom loſe by it, as courtiers are ſo ſenſible of their deficiency in merit, that they generouſly reward all who know how to daub them with the appearance of it."

He continued to write inceſſantly in various periodical publications. July 11th, he tells his ſiſter that he had pieces laſt month in ſeveral magazines; in The Goſpel Magazine, The Town and Country, The Court and City, The London, the Political Regiſter, &c. But all theſe exertions of his genius brought in ſo little profit, that he was ſoon reduced to the extremeſt indigence; ſo that at laſt, oppreſſed with poverty and diſeaſe, in a fit of deſpair, he put an end to his exiſtence, Auguſt 1770, with a doſe of poiſon. This unfortunate perſon, though certainly a moſt extraordinary genius, ſeems yet to have been a moſt ungracious compoſition. He was violent and impetuous to a ſtrange degree. From the firſt of the above cited letters he ſeems to have had a portion of ill humour and ſpleen more than enough for a lad of 17; and the editor of his Miſcellanies records, "that he poſſeſſed all the vices and irregularities of youth, and that his profligacy was at leaſt as conſpicuous as his abilities."

In 1777 were publiſhed in one volume 8vo, "Poems, ſuppoſed to have been written at Briſtol, by Thomas Rowley and others, in the 15th century: the greateſt part now firſt publiſhed from the moſt authentic copies, with an engraved ſpecimen of one of the MSS. To which are added, a Preface, an introductory Account of the ſeveral Pieces, and a Gloſſary." And in 1778, were publiſhed, in one volume 8vo, "Miſcellanies in Proſe and Verſe by Thomas Chatterton, the ſuppoſed author of the Poems publiſhed under the names of Rowley, &c."

Of Rowley's poems, we have the following account in the preface, given in the words of Mr George Catcot of Briſtol, to whom, it is ſaid, the public is indebted for them. "The firſt diſcovery of certain MSS. having been depoſited in Redclift church above three centuries ago, was made in the year 1768, at the time of opening the new bridge at Briſtol; and was owing to a publication in Farley's Weekly Journal, Oct. 1ſt, containing an account of the ceremonies obſerved at the opening of the old bridge, taken, as it was ſaid, from a very ancient MS. This excited the curioſity of ſome perſons to inquire after the original. The printer, Mr Farley, could give no account of it, or of the perſon who brought the copy; but, after much inquiry, it was diſcovered that this perſon was a youth between 15 and 16 years of age, whoſe name was Thomas Chatterton, and whoſe family had been ſextons of Redclift church for near 150 years. His father, who was now dead, had alſo been maſter of the free ſchool in Pile-ſtreet. The young man was at firſt very unwilling to diſcover from whence he had the original: but, after many promiſes made to him, was at laſt prevailed on to acknowledge that he had received this, together with many other MSS. from his father, who had found them in a large cheſt in an upper room over the chapel, on the north ſide of Redclift church." It is added, that ſoon after this Mr Catcot commenced an acquaintance with Chatterton, and partly as preſents, partly as purchaſes, procured from him copies of many of his MSS. in proſe and verſe; as other copies were diſpoſed of in like manner to others. It is concluded, however, that whatever may have been Chatterton's part in this very extraordinary tranſaction, whether he was the author, or only (as he conſtantly aſſerted) the copier of all theſe productions, he appears to have kept the ſecret entirely to himſelf, and not to have put it in any one's power to bear certain teſtimony either of his fraud or of his veracity.

This affair, however, hath ſince become the foundation of a mighty controverſy among the critics, which hath yet ſcarcely ſubſided. The poems in queſtion, publiſhed in 1777, were republiſhed in 1778, with an "Appendix, containing ſome obſervations upon their language; tending to prove that they were written, not by any ancient author, but entirely by Chatterton." Mr Warton, in the third volume of his Hiſtory of Engliſh Poetry, hath eſpouſed the ſame ſide of the queſtion. Mr Walpole alſo obliged the world with a Letter on Chatterton, from his preſs at Strawberry hill. On the other hand have appeared, "Obſervations" upon theſe poems, "in which their authenticity is aſcertained," by Jacob Bryant, Eſq; 1781, 2 vols. 8vo.; and another edition of the "Poems, with a Comment, in which their antiquity is conſidered and defended, by Jeremiah Milles, D. D. dean of Exeter, 1782," 4to. In anſwer to theſe two works, we have had three pamphlets: 1. "Curſory Obſervations on the Poems, and Remarks on the Commentaries of Mr Bryant and Dr Milles; with a ſalutary propoſal addreſſed to the friends of thoſe gentlemen." 2. "An Archæological Epiſtle to Dean Milles, editor of a ſuperb edition of Rowley's Poems, &c." 3. "An Inquiry into the authenticity of the Poems attributed to Thomas Rowley, in which the Arguments of the deans of Exeter and Mr Bryant are examined, by Thomas Warton;" and other pieces in the public prints and magazines: All preparatory to the complete ſettlement of the buſineſs in "A Vindication of the Appendix to the Poems called Rowley's, in reply to the Anſwers of the dean of Exeter, Jacob Bryant, Eſq; and a third Anonymous Writer; with ſome further Obſervations upon thoſe Poems, and an Examination of the Evidence which has been produced in ſupport of their Authenticity. By Thomas Tyrwhitt, 1782," 8vo.

CHAUCER, Sir Geoffrey, an eminent Engliſh poet in the 14th century, born at London in 1328. After he left the univerſity, he travelled into Holland, France, and other countries. Upon his return he entered himſelf in the Inner Temple, where he ſtudied the municipal laws of England. His firſt ſtation at court was page to Edward III. and he had a penſion granted him by that prince till he could otherwiſe provide for him. Soon after we find him gentleman of the king's privy chamber; next year, ſhield-bearer to the king. Eſteemed and honoured, he ſpent his younger days in a conſtant attendance at court, or for the moſt part living near it, in a ſquare ſtone houſe near the park-gate at Woodſtock, ſtill called *Chaucer's Houſe*.

Soon after, having got the duke of Lancaſter for his patron, Chaucer began every day to riſe in greatneſs. In 1373, he was ſent with other perſons to the republic of Genoa to hire ſhips for the king's navy (our want of ſhipping in thoſe times being uſually ſupplied by ſuch means); and the king was ſo well ſatisfied with his negotiation, that, on his return, he obtained a grant of a pitcher of wine daily in the port of London, to be delivered by the butler of England; and ſoon after was made comptroller of the cuſtoms for wool, wool fells, and hides; an office which he diſcharged with great diligence and integrity. At this period, Chaucer's income was about 1000l. a-year; a ſum which in thoſe days might well enable him to live, as he ſays he did, with dignity in office, and hoſpitality among his friends. It was in this meridian blaze of proſperity, in perfect health of body and peace of mind, that he wrote his moſt humorous poems. His ſatires againſt the prieſts were probably written to oblige his patron the duke of Lancaſter who favoured the cauſe of Wickliff, and endeavoured to expoſe the clergy to the indignation of the people. In the laſt year of Edward III. our poet was employed in a commiſſion to treat with the French; and in the beginning of King Richard's reign, he was in ſome degree of favour at court.

The duke of Lancaſter at laſt finding his views checked, began to abandon Wickliff's party: upon which Chaucer likewiſe, how much ſoever he had eſpouſed that divine's opinions, thought it prudent to conceal them more than he had done. With the duke's intereſt that of Chaucer entirely ſunk; and the former paſſing over ſea, his friends felt all the malice of the oppoſite party. Theſe misfortunes occaſioned his writing that excellent treatiſe, *The Teſtament of Love*, in imitation of Boethius on the Conſolation of Philoſophy. Being much reduced, he retired to Woodſtock, to comfort himſelf with ſtudy, which produced his admirable treatiſe of the *Aſtrolabe*.

The duke of Lancaſter at laſt ſurmounting his troubles, married Lady Catharine Swynford, ſiſter to Chaucer's wife; ſo that Thomas Chaucer, our poet's ſon, became allied to moſt of the nobility, and to ſeveral of the kings of England. Now the ſun began to ſhine upon Chaucer with an evening ray; for by the influence of the duke's marriage, he again grew to a conſiderable ſhare of wealth. But being now 70, he retired to Dunnington caſtle near Newbury. He had not enjoyed this retirement long before Henry IV. ſon of the duke of Lancaſter, aſſumed the crown, and in the firſt year of his reign gave our poet marks of his favour. But however pleaſing the change of affairs might be to him at firſt, he afterwards found no ſmall inconveniences from it. The meaſures and grants of the late king were annulled: and Chaucer, in order to procure freſh grants of his penſions, left his retirement, and applied to court: where, though he gained a confirmation of ſome grants, yet the fatigue of attendance, and his great age, prevented him from enjoying them. He fell ſick at London: and ended his days in the 72d year of his age, leaving the world as though he deſpiſed it, as appears from his ſong of *Flie from the Preſe*. The year before his death he had the happineſs, if at his time of life it might be ſo called, to ſee the ſon of his brother-in-law (Hen. IV.) ſeated on the throne. He was interred in Weſtminſter abbey; and in 1556, Mr Nicholas Bingham, a gentleman of Oxford, at his own charge, erected a handſome monument for him there. Caxton firſt printed the Canterbury Tales; but his works were firſt collected and publiſhed in one volume folio, by William Thynne, London, 1542. They were afterwards reprinted in 1561, 1598, 1602. Oxford, 1721.

Chaucer was not only the firſt, but one of the beſt poets which theſe kingdoms ever produced. He was equally great in every ſpecies of poetry which he attempted; and his poems in general poſſeſs every kind of excellence, even to a modern reader, except melody and accuracy of meaſure; defects which are to be attributed to the imperfect ſtate of our language, and the infancy of the art in this kingdom at the time when he wrote. "As he is the father of Engliſh poetry (ſays Mr Dryden), ſo I hold him in the ſame degree of veneration as the Grecians did Homer, or the Romans Virgil. He is a perpetual fountain of good ſenſe, learned in all ſciences, and therefore ſpeaks properly on all ſubjects. As he knew what to ſay, ſo he knows alſo when to leave off; a continence which is practiſed by few writers, and ſcarcely by any of the ancients, except Virgil and Horace." This character Chaucer certainly deſerved. He had read a great deal; and was a man of the world, and of ſound judgment. He was the firſt Engliſh poet who wrote *poetically*, as Dr Johnſon obſerves in the preface to his Dictionary, and (he might have added) who wrote like a gentleman. He had alſo the merit of improving our language conſiderably, by the introduction and naturalization of words from the Provençal, at that time the moſt poliſhed dialect in Europe.

CHALCIS, in *Ancient Geography*, the country of the Chauci, a people of Germany: divided into the *Minores*, now *Eaſt Frieſland*, and the county of *Oldenburg*; and into the *Majores*, now the duchy of *Bremen* and a part of *Lunenburg*.

CHAUD Medley, in *Law*, is of much the ſame import with *Chance Medley*. The former in its etymology ſignifies an affray in the heat of blood or paſſion: the latter, a caſual affray. The latter is in common ſpeech too often erroneouſly applied to any manner of homicide by miſadventure; whereas it appears by the ſtat. 24 Hen. VIII. c. 5. and ancient books (Standf. P. C. 16.), that it is properly applied to ſuch killing as happens in ſelf-defence upon ſudden encounter.

CHAL, a town of the Eaſt Indies, on the coaſt of Malabar, in the province of Baglana, and kingdom of Viſapour. Its river affords a good harbour for ſmall veſſels. The town is fortified, and ſo is the iſland on the ſouth ſide of the harbour. It had formerly a good trade, but is now miſerably poor. It was taken by the Portugueſe in 1507, to whom it ſtill belongs. It is 15 miles ſouth of Bombay, and five miles from the ſea. E. Long. 72. 45. N. Lat. 18. 30.

CHAULIEU, William Amfryede, Abbé d'Amale, one of the moſt polite and ingenious of the French poets, was born in 1639, and died at the age of 84. The moſt complete edition of his poems is that printed in two vols. 8vo. in 1733.

CHAUMONT, a town of France, in Champagne, and in the diſtrict of Baſſigni, of which it is the capital. It is ſeated on a mountain near the river Marne. E. Long. 5. 15. N. Lat. 48. 6.

CHAUNE, a town of France, in Picardy, and in the diſtrict of Sanſterre, with the title of a duchy. E. Long. 2. 55. N. Lat. 49. 45.

CHAUNTRY. See Chantry.

CHAUNY, a town of France, in Picardy, ſeated on the river Oiſe, in Chantry. E. Long. 3. 17. N. Lat. 49. 37.

CHAUVIN, Stephen, a celebrated miniſter of the reformed religion, born at Niſmes, left France at the revocation of the edict of Nantz, and retired to Rotterdam, where he began a new *Journal des Sçavans*; and afterwards removing to Berlin, continued it there three years. At this laſt place, he was made profeſſor of philoſophy, and diſcharged that office with much honour and reputation. His principal work is a philoſophical dictionary, in Latin, which he publiſhed at Rotterdam in 1692; and gave a new edition of it much augmented, at Lewarden, in 1703, folio. He died in 1725, aged 85.

CHAVEZ, a ſtrong town of Tralos-Montes in Portugal, ſeated at the foot of a mountain on the river Tamega. It has two ſuburbs, and as many forts; one of which looks like a citadel. Between the town and ſuburb of Magdalena, is an old Roman ſtone bridge about 92 geometrical paces long. W. Long. 7. 1. N. Lat. 41. 45.

CHAZELLES, Joan Matthew, a celebrated French mathematician and engineer, was born at Lyons in 1657. M. du Hamel, with whom he got acquainted, finding his genius incline towards aſtronomy, preſented him to M. Caſſini, who employed him in his obſervatory. In 1684, the duke of Mortemar made uſe of Chazelles to teach him mathematics; and, the year after, procured him the preferment of hydrography profeſſor for the galleys of Marſeilles, where he ſet up a ſchool for young pilots deſigning to ſerve aboard the galleys. In 1686, the galleys made four little campaigns or rather four courſes, purely for exerciſe. Chazelles went on board every time with them: kept his ſchool upon the ſea, and ſhowed the practice of what he taught. In the years 1687 and 1688, he made two other ſea campaigns, in which he drew a great many plans of ports, roads, towns, and forts, which were lodged with the miniſters of ſtate. At the beginning of the war, which ended with the peace of Ryſwick, ſome marine officers, and Chazelles among the reſt, fancied the galleys might be ſo contrived as to live upon the ocean; that they might ſerve to tow the men of war when the wind failed or proved contray, and alſo help to ſecure the coaſt of France upon the ocean. Chazelles was ſent to the weſt coaſts in July 1689, to examine the practicableneſs of this ſcheme; and in 1690, fifteen galleys new built ſet ſail from Rocheſort, and cruiſed as far as Torbay, in England, and proved ſerviceable at the deſcent upon Tinmouth. After this, he digeſted into order the obſervations he had made on the coaſts of the ocean; and drew diſtinct maps, with a portulan to them, viz. a large deſcription of every haven, of the depth, the tides, the dangers and advantages diſcovered, &c. Theſe maps were inſerted in the *Neptune Françoiſe*, publiſhed in 1692, in which year Chazelles was engineer at the deſcent at Oneille. In 1693, Monſieur de Pontchartrain, then ſecretary of ſtate for the marine, and afterwards chancellor of France, reſolved to get the *Neptune Françoiſe* carried on to ſecond volume, which was alſo to take in the Mediterranean. Chazelles deſired that he might have a year's voyage on this ſea, for making aſtronomical obſervations; and the requeſt being granted, he paſſed by Greece, Egypt, and the other parts of Turkey, with his quadrant and teleſcope in his hand. When he was in Egypt, he meaſured the pyramids: and finding the ſides of the largeſt preciſely facing the four cardinal points, naturally concluded this poſition to have been intended, and alſo that the poles of the earth and meridians had not ſince deviated. Chazelles likewiſe made a report of his voyage in the Levant, and gave the academy all the ſatiſfaction they wanted concerning the poſition of Alexandria: upon which he was made a member of the academy in 1695. He died in 1710.

CHAZINZARIANS, a ſect of heretics who roſe in Armenia in the ſeventh century. The word is formed of the Armenian *chazus*, "croſs." They are alſo called *ſtaurolatræ*, which in Greek ſignifies the ſame as *Chazinzarians* in Armenian, viz. *adorers of the croſs*; they being charged with paying adoration to the croſs alone. In other reſpects they were Neſtorians; and admitted two perſons in Jeſus Chriſt: Nicephorus aſcribes other ſingularities to them; particularly their holding an annual feaſt in memory of the dog of their falſe prophet Sergius, which they called *artzibartzes*.

CHESAPEAK bay, in North America, the entrance between Cape Henry and Cape Charles, running up 300 miles between Virginia and Maryland. It is navigable almoſt all the way for large ſhips, and has ſeveral navigable rivers that fall into it, by means of which ſhips go up to the very doors of the planters, to take in their lading of goods.—Here was a ſea engagement in 1781 between the Britiſh fleet under Admiral Graves conſiſting of 19 ſhips of the line, and the French fleet of 24 line-of-battle ſhips under the Count de Graſſe, which ended in the Count's keeping poſſeſſion of the bay, by which Lord Cornwallis and his whole army were made priſoners of war at York-town, being inveſted both by ſea and land by very ſuperior numbers.

CHEATS, are deceitful practices in defrauding, or endeavouring to defraud, another of his known right, by means of ſome artful device, contrary to the plain rules of common honeſty: as by playing with falſe dice, or by cauſing an illiterate perſon to execute a deed to his prejudice, by reading it over to him in words different from thoſe in which it was written, &c.—If any perſon deceitfully get into his hands or poſſeſſion any money or other things of any other perſon's, by colour of any falſe token, &c. being convicted, he ſhall have ſuch puniſhment by impriſonment, ſetting upon the pillory, or by any corporeal pain except pains of death, as ſhall be adjudged by the perſons before whom he ſhall be convicted.—As there are frauds which may be relieved civilly, and not puniſhed criminally; ſo there are other frauds which in a ſpecial caſe may not be helped civilly, and yet ſhall be puniſhed criminally. Thus, if a minor goes about the town, and, pretending to be of age, defrauds many perſons by taking credit for a conſiderable quantity of goods, and then inſiſting on his nonage, the perſons injured cannot recover the value of their goods, but they may indict and puniſh him for a common cheat. Perſons convicted of obtaining money or goods by falſe pretences, or of ſending threatening letters in order to extort money or goods, may be puniſhed with fine or impriſonment, or by pillory, whipping, or tranſportation.

CHEBRECHIN, a town of Poland, in the province of Ruſſia and palatinate of Belſkow. It is ſeated on the declivity of a hill, and the river Wierpi waters its walls, and afterwards falls into the river Bog. The Jews there are very rich. E. Long. 23. 51. N. Lat. 50. 35.

CHECAYA, in Turkiſh affairs, the ſecond officer of the janizaries, who commands them under the aga, and is otherwiſe called *protogero*.

There is alſo a checaya of the treaſury, ſtables, kitchen, &c. the word ſignifying as much as lieutenant, or the ſecond in any office.

CHECK, or Check-*Roll*, a roll or book, wherein are contained the names of ſuch perſons as are attendants and in the pay of the king, or other great perſonages, as their houſehold ſervants.

Clerk of the Check *in the king's houſehold*, has the check and controlment of the yeomen of the guard, and all the uſhers belonging to the royal family, allowing their abſence or defects in attendance, or diminiſhing their wages for the ſame, &c. He alſo, by himſelf or deputy, takes the view of thoſe who are to watch in the court, and has the ſetting of the watch, &c.

Clerk of the Check *in the royal dock yards*, an officer who keeps a muſter or regiſter of all the men employed aboard his majeſty's ſhips and veſſels, and alſo of all the artificers and others in the ſervice of the navy at the port where he is ſettled.

Check, in falconry, a term uſed of a hawk, when ſhe forſakes her proper game, to fly at pies, crows, rooks, or the like, that croſs her in her flight.

CHECKY, in *Heraldry*, is when the ſhield, or a bordure, &c. is chequered, or divided into chequers or ſquares, in the manner of a cheſsboard.

This is one of the moſt noble and moſt ancient figures uſed in armoury; and a certain author ſaith, that it ought to be given to none but great warriors, in token of their bravery; for the cheſsboard repreſents a field of battle; and the pawns placed on both ſides repreſent the ſoldiers of the two armies, which move, attack, advance, or retire, according to the will of the gameſters, who are the generals.

This figure is always compoſed of metal and colour. But ſome authors would have it reckoned among the ſeveral ſorts of furs.

CHEEK, in *Anatomy*, that part of the face ſituated below the eyes on each ſide.

Cheeks, a general name among mechanics, for almoſt all thoſe pieces of their machines and inſtruments, that are double and perfectly alike. Thus, the cheeks of a printing preſs are its two principal pieces: they are placed perpendicular, and parallel to each other; ſerving to ſuſtain the three ſommers, viz. the head, ſhelves, and winter, which bear the ſpindle and other parts of the machine. See *Printing Preſs*.

The cheeks of a turner's lathe, are two long pieces of wood, between which are placed the puppets, which are either pointed or otherwiſe, ſerving to ſupport the work and the mandrils of the workman. Theſe two pieces are placed parallel to the horizon, ſeparated from one another by the thickneſs of the tail of the puppets, and joined with tenons to two other pieces of wood placed perpendicularly, called the *legs of the lathe*.

Cheeks of the glazier's vice, are two pieces of iron joined parallel at top and bottom; in which are the axles, or ſpindles, little wheel, cuſhions, &c. whereof the machine is compoſed.

The cheeks of a mortar, or the *brackets*, in artillery, are made of ſtrong planks of wood, bound with thick plates of iron, and are fixed to the bed by four bolts; they riſe on each ſide of the mortar, and ſerve to keep her at what elevation is given her, by the help of ſtrong bolts of iron which go through both cheeks, both under and behind the mortar, betwixt which are driven quoins of wood; theſe bolts are called the *bracket bolts;* and the bolts which are put one in each end of the bed, are the traverſe bolts, becauſe with handſpikes the mortar is by theſe traverſed to the right or left.

Cheeks, in *Ship-building*, are two pieces of timber, fitted on each ſide of the maſt at the top, ſerving to ſtrengthen the maſts there. The uppermoſt bail or piece of timber in the beak of a ſhip is called the *cheek*. The knees which faſten the beak head to the ſhip are called *cheeks;* and the ſides of any block, or the ſides of a ſhip's carriage of a gun, are alſo called *cheeks*.

CHEESE, a ſort of food prepared of curdled milk purged from the ſerum or whey, and afterwards dried for uſe.

Cheeſe differs in quality according as it is made from new or ſkimmed milk, from the curd which ſeparates ſpontaneouſly upon ſtanding, or that which is more ſpeedily produced by the addition of runnet. Cream alſo affords a kind of cheeſe, but quite fat and butyraceous, and which does not keep long. Analyzed chemically, cheeſe appears to partake much more of an animal nature than butter. It is inſoluble in every liquid except ſpirit of nitre, and cauſtic alkaline ley. Shaved thin, and properly treated with hot water, it forms a very ſtrong cement if mixed with quicklime *. When prepared with hot water, it is recommended in the Swediſh Memoirs to be uſed by anglers as a bait; it may be made into any form, is not ſoftened by the cold water, and the fiſhes are fond of it.—As a food, phyſicians condemn the too free uſe of cheeſe. When new, it is extremely difficult of digeſtion: when old, it becomes acrid and hot; and, from Dr Percival's experiments, is evidently of a ſeptic nature. It is a common opinion that old cheeſe digeſts every thing, yet is left undigeſted itſelf; but this is without any ſolid foundation. Cheeſe made from the milk of ſheep digeſts ſooner than that from the milk of cows, but is leſs nouriſhing; that from the milk of goats digeſts ſooner than either, but is alſo the leaſt nouriſhing. In general, it is a kind of food fit only for the laborious, or thoſe whoſe organs of digeſtion are ſtrong.

Every country has places noted for this commodity: thus Cheſhire and Glouceſter cheeſe are famous in England; and the Parmeſan cheeſe is in no leſs repute abroad, eſpecially in France. This ſort of cheeſe is entirely made of ſweet cow-milk: but at Rochefort in Languedoc, they make it of ewes milk; and in other places it is uſual to add goat or ewes milk in a certain proportion to that of the cow. There is likewiſe a kind of medicated cheeſe made by intimately mixing the expreſſed juice of certain herbs, as ſage, baum, mint, &c. with the curd before it is faſhioned into a cheeſe.—The Laplanders make a ſort of cheeſe of the milk of their rein deer; which is not only of great ſervice to them as food, but on many other occaſions. It is a very common thing in theſe climates to have a limb numbed and frozen with the cold: their remedy for this is the heating an iron red hot, and thruſting it through the middle of one of theſe cheeſes; they catch what drops out, and with this anoint the limb, which ſoon recovers. They are ſubject alſo to coughs and diſeaſes of the lungs, and theſe they cure by the ſame ſort of medicine: they boil a large quantity of the cheeſe in the freſh deer's milk, and drink the decoction in large draughts warm ſeveral times a-day. They make a leſs ſtrong decoction of the ſame kind alſo, which they uſe as their common drink, for three or four days together, at ſeveral times of the year. For an account of the different proceſſes for making cheeſe, ſee Cheese, Agriculture *Index*.

Cheese-Rennet. See Galium and Runnet.

* See Cement.

CHEGOE, or Nigua, the Indian name of an inſect common in Mexico, and alſo found in other hot countries where it is called *pique*, is an exceeding ſmall animal, not very unlike a flea, and is bred in the duſt. It fixes upon the feet, and breaking inſenſibly the cuticle, it neſtles betwixt that and the true ſkin, which alſo, unleſs it is immediately taken out, it breaks, and pierces at laſt to the fleſh, multiplying with a rapidity almoſt incredible. It is ſeldom diſcovered until it pierces the true ſkin, when it cauſes an intolerable itching. Theſe inſects, with their aſtoniſhing multiplication, would ſoon depopulate thoſe countries, were it leſs eaſy to avoid them, or were the inhabitants leſs dexterous in getting them out before they begin to ſpread. On the other hand, nature, in order to leſſen the evil, has not only denied them wings, but even that conformation of the legs and thoſe ſtrong muſcles which are given to the flea for leaping. The poor, however, who are in ſome meaſure doomed to live in the duſt, and to an habitual neglect of their perſons, ſuffer theſe inſects ſometimes to multiply ſo far as to make large holes in their fleſh, and even to occaſion dangerous wounds.

CHEIRANTHUS, stock-gilliflower, or *Wall-flower*. See Botany *Index*.

CHEKAO, in *Natural Hiſtory*, the name of an earth found in many parts of the Eaſt Indies, and ſometimes uſed by the Chineſe in their porcelain manufactures. It is a hard and ſtony earth; and the manner of uſing it is this: they firſt calcine it in an open furnace, and then beat it to a fine powder. This powder they mix with large quantities of water: then ſtirring the whole together, they let the coarſer part ſubſide; and pouring off the reſt yet thick as cream, they leave it to ſettle, and uſe the matter which is found at the bottom in form of a ſoft paſte, and will retain that humidity a long time. This ſupplies the place of the earth called *hoache*, in the making of that elegant ſort of china-ware which is all white, and has flowers which ſeem formed by a mere vapour within its ſurface. The manner of their uſing it is this: they firſt make the veſſel of the common matter of the manufacture; when this is almoſt dry, they paint upon it the flowers, or whatever other figures they pleaſe, with a pencil dipt in this preparation of the chekao; when this is thoroughly dry, they cover the whole veſſel with the varniſh in the common way, and bake it as uſual. The conſequence is, that the whole is white: but the body of the veſſel, the figures, and the varniſh, being three different ſubſtances, each has its own particular white; and the flowers being painted in the fineſt white of all, are diſtinctly ſeen through the varniſh upon the veſſel, and ſeem as if traced by a vapour only. The hoache does this as well as the chekao; and has beſides this the quality of ſerving for making the porcelain ware either alone, or in the place of kaolin: the chekao has not this property, nor any other ſubſtance beſides this hoache, which appears to be the ſame with our ſteatites or ſoap-rock.

CHEKE, Sir John, a celebrated ſtateſman, grammarian, and divine, of an ancient family in the iſle of Wight, was born at Cambridge in the year 1514, and educated at St John's college in that univerſity; where, after taking his degrees in arts, he was firſt choſen Greek lecturer, and in 1540 profeſſor of that language, with a ſtipend of 40l. a-year. In this ſtation he was principally inſtrumental in reforming the pronunciation of the Greek language, which, having been much neglected, was imperfectly underſtood. About the year 1543 he was incorporated maſter of arts at Oxford, where, we are told, he had ſtudied for ſome time. In the following year he was ſent to the court of King Henry VIII. and appointed tutor for the Latin language, jointly with Sir Anthony Cooke, to Prince Edward, about which time he was made canon of the college newly founded in Oxford: wherefore he muſt have now been in orders. On the acceſſion of his royal pupil to the crown, Mr Cheke was firſt rewarded with a penſion of 100 merks, and afterwards obtained ſeveral conſiderable grants from the crown. In 1550 he was made chief gentleman of the privy-chamber, and was knighted the following year; in 1552, chamberlain of the exchequer for life; in 1553, clerk of the council; and ſoon after ſecretary of ſtate and privy-counſellor. But theſe honours were of ſhort duration. Having concurred in the meaſures of the duke of Northumberland for ſettling the crown on the unfortunate Jane Grey, and acted as her ſecretary during the nine days of her reign, on the acceſſion of Queen Mary, Sir John Cheke was ſent to the tower, and ſtript of the greateſt part of his poſſeſſions. In September 1554 he obtained his liberty, and a licenſe from her majeſty to travel abroad. He went firſt to Baſil, thence to Italy, and afterwards returned to Straſburg, where he was reduced to the neceſſity of reading Greek lectures for ſubſiſtence. In 1556 he ſet out in an evil hour to meet his wife at Bruſſels: but, before he reached that city, he was ſeized by order of King Philip II. hoodwinked, and thrown into a waggon; and thus ignominiouſly conducted to a ſhip, which brought him to the tower of London. He ſoon found that religion was the cauſe of his impriſonment; for he was immediately viſited by two Romiſh prieſts, who piouſly endeavoured to convert him, but without ſucceſs. However, he was at laſt viſited by Fleckenham; who told him from the queen, that he muſt either comply or burn. This powerful argument had the deſired effect; and Sir John Cheke accordingly complied in form, and his lands, upon certain conditions, were reſtored; but his remorſe ſoon put an end to his life. He died in September 1557, at the houſe of his friend Mr Peter Oſborne in Wood-ſtreet, London, and was buried in St Alban's church. He left three ſons, the eldeſt of whom, Henry, was knighted by Queen Elizabeth. He wrote, 1. A Latin tranſlation of two of St Chryſoſtom's homilies. Lond. 1543, 4to. 2. The Hurt of Sedition. Lond. 1549, 1576, 1641. 3. Latin Tranſlation of the Engliſh Communion Service. Printed among Bucer's opuſcula. 4. *De pronunciatione Græcæ*. Baſil, 1555, 8vo. 5. Several letters publiſhed in his life by Strype; and a great number of other books.

CHE-KYANG, or Tche-kiang, a maritime province of China, and one of the moſt conſiderable in the empire; is bounded on the ſouth by Fo-kien; on the north and weſt by Kiang-nan and Kiangſi; and on the eaſt by the ſea. The air is pure and healthful, and the ſoil fertile, being watered by a number of rivers and canals, as well as ſprings and lakes. The chief produce is ſilk; a vaſt quantity of which is cultivated here, and for which the whole country is covered with mulberry trees. Theſe are purpoſely checked in their growth by the natives, experience having taught them, that the leaves of the ſmalleſt trees produce the beſt ſilk. The ſtuffs made in this province, which are embroidered with gold and ſilver, are reckoned the beſt in the empire; and notwithſtanding a vaſt exportation to the Japan and Philippine iſlands, as well as to every part of China, and to Europe, ſuch an abundance is left in the province, that a complete ſuit of ſilk may be bought here as cheap as one of the coarſeſt woollen in France.

This province is alſo remarkable for a particular ſpecies of muſhrooms, which are exported to every part of the empire. They are pickled, and then dried; when they will keep good for a whole year. When uſed they muſt be ſoaked in water, which renders them as freſh as at firſt. Here alſo the tallow tree is met with; and the province affords excellent hams, and thoſe ſmall gold fiſhes with which the ponds are uſually ſtocked.

Che-kyang contains 11 cities of the firſt claſs, 72 of the third, und 18 fortreſſes, which, in Europe, would be accounted large cities. The principal of theſe are, 1. Hang-tcheou-fou, the metropolis, accounted by the Chineſe to be the paradiſe of the earth. It is four leagues in circumference, excluſive of the ſuburbs; and the number of its inhabitants is computed at more than a million, and 10,000 workmen are ſuppoſed to be employed within its walls in manufacturing of ſilk. Its principal beauty is a ſmall lake, cloſe to the walls on the weſtern ſide, the water of which is pure and limpid, and the banks almoſt everywhere covered with flowers. Its banks are likewiſe adorned with halls and open galleries ſupported by pillars, and paved with large flag ſtones for the convenience of thoſe who are fond of walking; and the lake itſelf is interſected with cauſeways caſed with cut ſtone, openings covered with bridges being left in them for the paſſage of boats. In the middle are two iſlands with a temple and ſeveral pleaſure houſes, and the emperor has a ſmall palace in the neighbourhood. The city is garriſoned by 3000 Chineſe and as many Tartars, and has under its juriſdiction ſeven cities of the third claſs. 2. Hou-tcheou-fou is alſo ſituated on a lake, and manufactures an incredible quantity of ſilk, inſomuch, that the tribute of a city under its juriſdiction amounts to more than 500,000 ounces of ſilver. 3. Ning-po-fou, by Europeans called Liampo, is an excellent port, oppoſite to Japan. Eighteen or twenty leagues from it is an iſland called Tcheou-chan, where the Engliſh firſt landed on their arrival at China. 4. Ning-po is remarkable for the ſilk manufactured there, which is much eſteemed in foreign countries, eſpecially Japan, where it is exchanged for gold, ſilver, and copper. 5. Chao-hing-fou, ſituated in an extenſive and fertile plain, is remarkable for a tomb about half a league diſtant, which is ſaid to be that of *Yu*. The people of this province are ſaid to be the moſt verſed in chicanery of any in China. 6. Tchu-tcheou-fou, remarkable for having in its neighbourhood pines of an extraordinary ſize, capable of containing 40 men in their trunks. The inhabitants are ingenious, polite, and courteous to ſtrangers, but very ſuperſtitious.

CHELIDONIAS, according to Pliny, an anniverſary wind, blowing at the appearance of the ſwallows; otherwiſe the Favonius, or Zephyrus.

CHELIDONIUM, CELADINE, and HORNED or PRICKLY POPPY. See BOTANY *Index*.

CHELIDONIUS LAPIS, in *Natural Hiſtory*, a ſtone ſaid by the ancients to be found in the ſtomachs of young ſwallows, and greatly eſteemed for its virtues in the falling ſickneſs.

CHELM, a town of Poland, capital of a palatinate of the ſame name. It is ſituated in the province of Red Ruſſia. E. Long. 23. 30. N. Lat. 51. 25.

CHELMSFORD, the county town of Eſſex, ſituated on the river Chelmer, in E. Long. 0. 30. N. Lat. 51. 40. It ſends two members to parliament.

CHELONE. See BOTANY *Index*.

CHELSEA, a fine village ſituated on the northern bank of the river Thames, a mile weſtward of Weſtminſter, remarkable for a magnificent hoſpital of invalids and old decrepid ſoldiers; and a pleaſure houſe, called Ranelagh, to which a great deal of fine company reſort in ſummer; and a noble botanic garden belonging to the company of apothecaries. The royal hoſpital of invalids was begun by Charles II. carried on by James II. and finiſhed by King William. It conſiſts of a vaſt range of buildings, that form three large ſquares, in which there is an uncommon air of neatneſs and elegance obſerved. It is under the direction of commiſſioners, who conſiſt generally of the officers of ſtate and of war. There is a governor with 500l. ſalary, a lieutenant-governor with 400l. and a major with 250l. beſides inferior officers, ſerjeants, corporals, and drums, with above 400 men, who all do garriſon duty; and there are above 10,000 out-penſioners who receive an annuity of 7l. 12s. 6d. each; all which expence is defrayed by a poundage deducted from the army, deficiencies being made good by parliament.—The botanic garden is very extenſive, enriched with a vaſt variety of domeſtic and exotic plants, the original ſtock of which was given to the apothecaries of London by Sir Hans Sloane.—At Ranelagh garden and amphitheatre, the entertainment is a fine band of muſic, with an organ and ſome of the beſt voices: and the regale is tea and coffee.

CHELTENHAM, or CHILTENHAM, a market town of Glouceſterſhire, ſeven miles north-eaſt of Glouceſter. W. Long. 2. 10. N. Lat. 51. 50. It is chiefly remarkable for its mineral waters, of the ſame kind with thoſe of Scarborough. See SCARBOROUGH.

CHEMISE, in *Fortification*, the wall with which a baſtion, or any other bulwark of earth is lined for its greater ſupport and ſtrength: or it is the ſolidity of the wall from the talus to the ſtone row.

Fire CHEMISE, a piece of linen cloth, ſteeped in a compoſition of oil of petrol, camphor, and other combuſtible matters, uſed at ſea to ſet fire to an enemy's veſſel.

CHEMISTRY.

INTRODUCTION.

1 Definition. CHEMISTRY is defined by Dr Black, to be "the ſtudy of the effects produced by heat and by mixture, in all bodies, or mixtures of bodies, natural or artificial, with a view to the improvement of the arts, and the knowledge of nature:" or, according to the definition propoſed by the learned editor of his lectures, "chemiſtry is the ſtudy of the effects of heat and mixture, with the view of diſcovering their general and ſubordinate laws, and of improving the uſeful arts."

Fourcroy has defined "chemiſtry to be that ſcience which teaches the knowledge of the intimate and reciprocal action of all the bodies in nature on one another." To this definition it has been objected, that it requires much explanation, that the terms reciprocal and intimate action not being readily underſtood, would need new definitions to explain them, and that it embraces more than what ſtrictly belongs to the ſcience of chemiſtry. When motion is communicated, or taken away by the colliſion of different bodies, the action between theſe bodies is intimate and reciprocal; but the ſtudy of this action belongs to mechanics, and not to chemical ſcience.

Perhaps no definition of chemiſtry has yet been given which is of ſufficient logical preciſion to be entirely free from objection. The object of chemiſtry however, admits of no ambiguity. It is the province of natural hiſtory to arrange and diſtribute natural bodies into claſſes and orders, each being accurately characterized, ſo that the objects which it includes may be readily recognized and diſtinguiſhed by eaſy marks of reference. Mechanical ſcience is employed about the external properties of bodies, and their effects on each other, the force and meaſure of which are ſubject to calculation; but it is the object of chemiſtry to diſcover the component parts of bodies, to examine the properties and uſes of the combinations formed, either naturally or artificially, from theſe ſimple ſubſtances, and to obſerve and trace the laws by which theſe combinations take place.

SECT. I. *Diviſion of Natural Knowledge.*

2 Variety of objects immenſe. When we conſider the immenſe and endleſs variety of objects which preſent themſelves to the eye, it muſt appear, at firſt ſight, impoſſible to acquire even a general knowledge of their qualities and properties. And, indeed, the longeſt life, with the moſt vigorous mind and the moſt indefatigable induſtry, would be greatly inadequate to the taſk of examining every individual object. Hence it is, by a law of the human mind, that we arrange the objects of our inveſtigations into certain claſſes, the individuals of which are found to poſſeſs certain general properties. Theſe are again ſubdivided into other claſſes with additional diſcriminative marks; and theſe laſt are ſtill farther ſubdivided, till we arrive at the individual; and, if the arrangement be correct, this muſt poſſeſs all the characteriſtic marks of reference to the general and ſubordinate diviſions of that claſs of objects to which it belongs. In this way the mind is aided in its inveſtigations, and the communication of knowledge is facilitated and improved.

3 Natural hiſtory. Thus it is the province of natural hiſtory to arrange the objects which come under our obſervation, and to deſcribe them with ſuch preciſion and accuracy as they may be eaſily diſtinguiſhed from each other. It may be conſidered as a deſcriptive view of the material world in a ſtate of reſt or inaction, without taking into account the motions or mutual action of bodies on each other. It is the firſt ſucceſsful ſtep in the progreſs of knowledge.

4 Natural philoſophy. But the operations of nature are ſeldom at reſt. Change ſucceeds change, new combinations are formed, and new productions make their appearance. The primary planets revolve round the ſun as their centre; the ſecondary planets, or the moons, attracted by the primary, perform ſimilar revolutions; the air of the atmoſphere preſſes on the ſurface of the earth with a certain force; a ſtone, when unſupported, falls to the earth in a courſe directed towards its centre; water deprived of a certain portion of heat becomes ſolid, and appears in the form of ice; when combined with a greater portion of heat than what is neceſſary to retain it in the fluid ſtate, it aſſumes the form of vapour, aſcends into the atmoſphere, is there by certain proceſſes robbed of its heat, and re-appears in the form of rain; or, when a greater portion is abſtracted, takes that of ſnow or hail, and falls to the earth. A ſeed is put into the ground; and if heat, air, and moiſture be applied, it germinates and ſprings up; and, with the addition of light, if the operation of the ſame agents be continued, it becomes a new plant, puts forth leaves and flowers, and produces ſeeds ſimilar to that from which it ſprung.

5 Phyſics. Now to determine what are theſe changes, to obſerve the laws by which ſuch changes are effected, and to aſcertain the meaſure and quantity of the effect produced, belong to that department of knowledge which is included under the general term *natural philoſophy* or *phyſics*. But of theſe changes or motions, ſome are obvious and palpable; others entirely elude our ſenſes. We ſee a ſtone deſcend to the earth; and experience informs us, that it falls with a force in a certain proportion to its weight and the height from which it fell. The peculiar change or motion which takes place when water aſſumes the ſolid form, when a fluid undergoes the proceſs of fermentation, or when a combuſtible body is burned, is altogether imperceptible. Theſe motions are too minute to be recognized. The effect is produced before we can diſcover the change.

6 Chemiſtry. Thus natural philoſophy divides itſelf into two great branches. The objects of the *firſt* are the ſenſible changes or motions which are obſerved in the material world; and the conſideration of theſe objects is, properly ſpeaking, natural philoſophy or phyſics. The *ſecond* great branch which is employed in diſcovering

the laws, and appreciating the effects, of the inſenſible motions of bodies, conſtitute the ſcience of chemiſtry (A).

Sect. II. *Of the Objects and Importance of Chemiſtry.*

The importance and extenſive utility of this ſcience muſt appear obvious to thoſe who have at all conſidered the ſubject. But for the ſake of othres who are yet unacquainted with it, we ſhall take a general view of the objects which it embraces, and the advantages to be derived from the ſtudy of chemiſtry, whether in explaining many of the ſtriking operations of nature, or in improving the arts of life.

7 Uſeful in explaining natural phenomena;

The moſt wonderful effects, after frequent repetition, become familiar, and ceaſe to produce any emotion in the mind. It is on this account that many of the moſt ſtriking appearances of nature paſs unheeded as trifling occurrences, and are unnoticed by common obſervers. Had we been always accuſtomed to the rigour of winter, and never known the genial warmth of ſpring, or experienced the ripening ſummer's heat, the aſtoniſhing changes effected by the return of theſe ſeaſons could not fail to fill us with admiration. Theſe changes are of ſuch univerſal influence, that they are limited to no department of nature. Their beneficial effects are felt in the inanimate as well as in the animated creation. The ſame power which is ſeen in the gay profuſion of the vegetable tribes, reſtores to a new exiſtence myriads of animals, whoſe vital functions had been ſuſpended. The air, the earth, the waters, ſwarm with life.

The principal agent in the production of theſe changes is heat; an agent, the moſt powerful and irreſiſtible in its operations, unlimited in its effects, and extenſive in its importance and utility. This agent, therefore, acting ſo powerfully in chemical operations, becomes an eſſential object of chemical ſcience. Cloſely connected with heat is light, which is alſo a powerful agent in many of the proceſſes of nature. This, too, is neceſſarily a ſubject of chemical inveſtigation, not leſs curious and intereſting. Such, indeed, is the univerſal importance of light and heat in all the proceſſes of nature, that no change takes place, no new combination is formed, or new product makes its appearance, in which the one or the other, or both, are not evolved or abſorbed.

In the knowledge of the conſtitution of the atmoſphere, in inveſtigating the changes to which it is ſubject, the variations of temperature, winds, dew, rain, hail, and ſnow, chemiſtry is our principal, our only ſatisfactory guide. Theſe remarkable changes are to be conſidered as immenſe chemical operations, and can only be explained by chemical laws.

8 To man in the ſtudy of

But in the midſt of the infinite variety of objects from which man muſt derive the means of his comfort, his happineſs and his luxuries, the means, it might be added, of his very exiſtence, chemiſtry affords him the moſt important aid. Whether his reſearches be carried into the mineral, the vegetable, or the animal kingdoms, the ſtudy and cultivation of chemical ſcience become eſſentially requiſite for the ſucceſsful progreſs of his inveſtigations.

9 Minerals.

Of the importance of chemiſtry to the mineralogiſt, the limited and unſettled ſtate of this ſcience previous to the improvements of modern chemiſtry, is a convincing proof. In mineralogy, the knowledge of chemiſtry is not only neceſſary in detecting and diſcriminating the various ſubſtances of which the globe which we inhabit is compoſed, in ſeparating and purifying theſe ſubſtances, but alſo in preparing and accommodating them to the numerous purpoſes of life.

10 Vegetables.

Of the knowledge which we poſſeſs of the vegetable kingdom, chemiſtry furniſhes a very large ſhare. It is from this ſcience that we derive the means of tracing the progreſs of vegetation, of illuſtrating the peculiar functions of plants, and diſcovering the compounds which are formed from a few ſimple principles, the nature and properties of theſe compounds, and their relative proportions, which exhibit an immenſe variety of new productions, many of them of the utmoſt importance to man, on account of their nutritious qualities, or indirectly uſeful to him by affording nouriſhment to thoſe animals which he employs as food. Hence the advantage of applying chemical knowledge to agriculture, in determining the nature of the ſoil fit for the reception of plants, their proper food, and the mode of ſupplying it in the preparation of manures. With theſe objects in view, chemiſtry holds out incalculable advantages in the improvement of many departments of agriculture and rural economy, many of which, from the rapid and ſucceſsful progreſs of the ſcience, there is no room to hope, may be ſoon obtained.

11 Animals.

Nor is the application of chemical ſcience to the economy of animals leſs limited in its importance and utility. It not only contributes to the means of decompoſing animal matters, and of exhibiting and examining ſeparately the conſtituent parts of animal ſubſtances; but alſo ſerves to explain in ſome meaſure many of the eſſential functions of the living animal body: ſuch are digeſtion, reſpiration, ſecretion, which, ſo far as matter is concerned, and the changes which it undergoes, are to be conſidered as true chemical proceſſes, and can only be inveſtigated by chemical principles. But it is here neceſſary to obſerve, that the functions of the living vegetable or animal cannot be wholly accounted for from the nature of chemical action, without taking into conſideration the exiſtence of the vital principle, which counteracts and regulates the operation of chemical agents, aids and promotes the beneficial effects of thoſe that are uſeful to its health and growth, and reſiſts and deſtroys thoſe that are hurtful.

12 Medicine.

The utility of chemiſtry in medicine is too obvious to require much illuſtration. Such, indeed, is its importance that it is now univerally received and acknowledged as one of the eſſential branches of medical education. So far as the principles of chemiſtry can be applied in inveſtigating the nature of the functions

of

(A) For this view of the diviſion of natural knowledge, we are indebted to the Introductory Lectures of Profeſſor Robinſon of Edinburgh.

of the animal body in a ſtate of health, or can be employed in accounting for the irregular action of theſe powers, whether exceſſive or deficient, which indicates a deranged ſtate of the functions, and conſtitutes diſeaſe, its relation to medicine muſt be conſidered cloſe and intimate. But the medical art comprehends more than a bare knowledge of the ſtructure and functions of the animal body. It alſo includes an accurate knowledge of the ſubſtances employed as remedies, of their nature and properties as ſimple ſubſtances, and their new qualities and effects under new combinations. This knowledge can only be acquired by the ſtudy of chemiſtry, which is indebted to medicine for ſome part of its progreſs as an art, in the diſcoveries which were accidentally made by the rude and uncertain experiments of medical practitioners in the early ages, to aſcertain the ſenſible qualities and ſalutary effects of the remedies which they employed. Chemiſtry, by its rapid progreſs in modern times, has amply repaid theſe advantages, and in the hands of the intelligent and accurate obſerver, has greatly contributed to give more rational and ſimple views of medical ſcience.

13 The arts.

In conſidering the application of chemiſtry to the improvement of the arts of civilized life, a wide field of contemplation opens to our view. So extenſive indeed are its influence and importance, that in moſt of the arts, many of the proceſſes, in ſome all that are employed, depend on chemical principles. Barely to mention ſome of theſe arts will afford ample illuſtration of its extenſive utility. In the art of extracting metals from their ores, in purifying and combining them with each other, and in forming inſtruments and utenſils, whether for uſeful or ornamental purpoſes, almoſt all the proceſſes are purely chemical. The eſſential improvements which modern chemiſtry has introduced in the manufacture of glaſs and porcelain ſhew its importance and utility in theſe arts. Nor has it contributed leſs by the application of its principles to the arts of tanning, ſoapmaking, dyeing, and bleaching. All the proceſſes in baking, brewing, and diſtilling, moſt of the culinary arts, and many others in domeſtic economy, are chemical operations. In ſhort, wherever, in any of the proceſſes of nature or of art, the addition or the abſtraction of heat takes place; wherever ſubſtances in combination are to be decompoſed or ſeparated; wherever the union of ſimple ſubſtances is wanted, and new compounds are formed, there effects are produced which can only be explained and underſtood by chemical principles.

From this view of the extenſive application of chemical ſcience in explaining many of the operations of nature, and in elucidating many of the proceſſes of the arts of life, thoſe who have not conſidered the objects which it embraces will be enabled to judge of the importance of this ſtudy.

14 As a ſcience.

But however much we may be intereſted in obſerving and admiring the changes and effects produced by chemical action, if we extend our views, and conſider chemiſtry as a ſcience, as the ſubject of philoſophical inveſtigation, it will command a greater ſhare of our attention and ſtudy. And perhaps there is no ſtudy better calculated to promote and encourage that generous and ardent love of truth which confers dignity and ſuperiority on thoſe who ſucceſsfully purſue it. Chemiſtry is not one of thoſe barren diſcuſſions which terminate in the diſcovery of ſome ſpeculative truth, which is merely gratifying to curioſity. In this view, indeed, no ſcience holds out more intereſting ſubjects of reſearch, in the ſingular and ſurpriſing changes which everywhere preſent themſelves. And it is ſurely no ſmall recommendation to the ſtudy of chemiſtry, that while we ſtore the mind with intereſting truths, we add ſomething to the ſtock of human knowledge, which is perhaps immediately applicable to ſome of the moſt important purpoſes of life. Thus might the value of the facts and diſcoveries in any ſcience be fairly eſtimated, in proportion as they enlarge our reſources by their uſeful application, and intereſt and gratify the mind as ſubjects of curious ſpeculation. From both theſe conſiderations the whole range of chemical facts derives the higheſt value; and from theſe conſiderations chemiſtry is entitled to a diſtinguiſhed place among the ſciences.

15 In contemplating the works of nature.

Chemiſtry has yet a higher claim to our attention and conſideration, as it affords us ſome of the moſt ſtriking proofs of the wiſdom and beneficence of the Creator of the univerſe. A machine conſtructed by human art is admired according to the ſimplicity of its contrivance, and the extent of its uſefulneſs; and in proportion to the perfection which we diſcover, we eſtimate the ingenuity and excellence of the plan of the artiſt. But the works of man, with all his boaſted ſkill and attainments, ſink into nothing when brought into compariſon with the works of nature. In our examination of the former, every ſtep of our progreſs is obſcured with defects: in contemplating the latter, we behold perfection riſe on perfection, and new wonders meet our view. By the aid which we derive from chemiſtry we are enabled to take a minuter ſurvey of the great ſyſtem of the univerſe. And ſo far as our limited powers can comprehend it, the whole is nicely balanced and adjuſted, and all its changes tend to the moſt beneficial purpoſes. What on a ſuperficial view were ſeeming imperfections and defects, a cloſer inſpection points out to be real excellencies. In all the changes which are conſtantly going forward, the more cloſely we obſerve and examine them, the more we ſhall admire the ſimple means by which they are accompliſhed, and the intelligent deſign and perfect wiſdom which are diſplayed in the beneficial ends to which they are directed.

Sect. III. *Hiſtory of Chemiſtry.*

The word chemiſtry, which is ſuppoſed to have been of Egyptian origin, ſeems to have been firſt uſed in a very extenſive ſenſe (B). It appears to have included

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(B) According to ſome it is derived from the word *kema*, which was ſuppoſed to be a book of ſecrets given to the women by the demons. Others derive it from *Cham* the ſon of Noah, from whom Egypt took the name of *Chemie*, or *Chamie*. Sometimes the origin of the word is aſcribed to *Chemmis*, a king of the Egyptians; and cluded all the knowledge which the ancients poſſeſſed of natural objects. It was afterwards more limited in its ſignification, and ſolely confined to the art of working metals. The great importance which the ancients attached to this art was probably the cauſe of this limitation. Such indeed was its importance, that thoſe who were ſuppoſed to have diſcovered or improved it, were regarded by mankind as their greateſt benefactors. They were raiſed above the level of the human race, were deemed worthy of being enrolled among the gods; and temples and ſtatues were conſecrated to their honour.

It is not neceſſary minutely to trace the hiſtory of chemiſtry to the remote periods of antiquity, or labour to prove its origin to be coeval with the early ages of the world. Man indeed could not exiſt long without ſome knowledge of chemical proceſſes; and as he improved in civilization and accurate obſervation, this knowledge muſt have been improved and extended. Tubal-Cain, who is mentioned in the ſacred Scriptures, as a worker in metals, and is ſuppoſed to have given riſe to the fabulous ſtory of Vulcan, in ancient mythology and poetry, is conſidered by ſome as the firſt chemiſt whoſe name has been tranſmitted to the preſent time. 16 Chemiſtry exiſted as an art. But although the working of metals, and other chemical arts, were known in the earlieſt ages of the world; and among the Egyptians, Greeks, and Romans, many of the arts dependent on chemiſtry had reached ſome degree of perfection; yet this knowledge muſt be regarded as conſiſting only of a number of ſcattered, unconnected facts, which deſerve not to be dignified with the name of ſcience. A carpenter may erect a piece of machinery, arranged and conſtructed exactly ſimilar to what he has ſeen, without the knowledge of a ſingle principle of its conſtruction; but the man of ſcience, who can neither handle the axe nor the chiſſel, obſerves and eſtimates the power and operation of all its parts, and determines the general effect of the whole machine.

Nor will it afford us much inſtruction to purſue the ſuppoſed hiſtory of chemiſtry, even to a later period. Moſes, who is ſaid to have been ſkilled in all the wiſdom of the Egyptians, has been ranked among the number of the firſt chemiſts; and as a proof of his knowledge of chemiſtry, the means he employed of diſſolving the golden calf made by the Iſraelites, to render it potable, are adduced. It is ſaid, that Democritus, of all the Greeks who travelled into Egypt to acquire knowledge, was alone admitted into their myſteries. 17 among the Egyptians. According to Diodorus Siculus, the art of chemiſtry had made very conſiderable progreſs among the Egyptians. The knowledge of their prieſts is ſuppoſed to have conſiſted chiefly of chemical proceſſes. They were acquainted, it is ſaid, with the preparation of many medicines, perfumes, plaſters, and ſoaps; they uſed burnt aſhes as cauſtic ſubſtances; they fabricated bricks, glaſs, porcelain; they painted on glaſs, and practiſed the art of gilding with ſilver and gold. They extracted natron or ſoda from the mud of the Nile. They prepared alum, ſea-ſalt, and ſal ammoniac; and beſides working in gold and copper, they poſſeſſed many other proceſſes in metallurgy. The extraction of oils, and the preparation of wine and vinegar, were well known; and they were alſo acquainted with the art of dyeing ſilk by means of mordants.

18 Greeks. Fewer traces of chemiſtry are found among the Greeks, although they derived the knowledge of many of the arts from Egypt. The ancient philoſophers of Greece, as Pythagoras, Thales, and Plato, were more devoted to the cultivation of mathematical and aſtronomical knowledge, than the phyſical ſciences. Some chemical arts, however, were not unknown to this people. The alloy of metals formed at Corinth has been much celebrated. Cinnabar was employed in ſome parts of Greece. Tychius knew the art of tanning leather; Plato has deſcribed the proceſs of filtration; Hippocrates was acquainted with that of calcination; Galen ſpeaks of diſtillation *per deſcenſum*, and the word *embic* is mentioned by Dioſcorides a long time before the Arabic particle *al* was prefixed to it. According to Athenæus, there was a manufactory of glaſs eſtabliſhed at Leſbos. Democritus of Abdera prepared and examined the juices of plants: Ariſtotle and Theophraſtus treated of ſtones and of metals.

19. Phœnicians. The Phœnicians are ſpoken of as being acquainted with the making of glaſs, and the celebrated Tyrian purple was found among this people. They were alſo ſkilled in the working of metals and other mineral ſubſtances. The Perſians are ſaid firſt to have diſtinguiſhed the metals by the names of the planets, which they retained for many centuries.

20 Chineſe. Among the Chineſe, if we may believe their hiſtorians, many chemical arts were known from the earlieſt ages: they were acquainted with nitre, borax, alum, gunpowder, verdigris, mercurial ointments, ſulphur, and colouring matters; nor were the arts of dyeing linen and ſilk, paper-making, manufacturing of pottery and porcelain, unknown. They were ſkilled in the art of alloying metals, and in the working of ivory and of horn. From the early knowledge which the Chineſe poſſeſſed of theſe arts, they have been ſuppoſed by ſome to have been a colony from Egypt.

21. Romans. The wars in which the Romans were almoſt conſtantly engaged, and the ſpirit which prompted them to military affairs, gave them neither time nor taſte to cultivate and improve the arts of peace. Chemiſtry, therefore, appears to have been little known among that people. Petronius indeed ſpeaks of malleable glaſs, which was preſented to Cæſar; and the ſame, or a ſimilar fact, is mentioned by Pliny with regard to Tiberius. But this art, it appears, was long known before the time of the Romans.

To us it may appear ſomewhat ſingular, that chemiſtry, now of ſuch univerſal importance to mankind, ſhould be indebted, in ſome meaſure, for its origin as an art, and for ſome part of its progreſs, to one of the leſs noble or generous of the human paſſions. Yet, in its early dawn, it was cultivated by men who were inſtigated

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and ſometimes to the Greek word χυμος, which ſignifies *liquid*, becauſe the art was at firſt applied in the preparation of liquids; and ſometimes to the Greek verb χεω "to pour out," becauſe chemiſtry is the art of fuſing metals.

ſtigated by avarice to proſecute and ſtudy it. About the 10th century, or perhaps earlier, a ſet of men aroſe, and continued to flouriſh till the 16th, who aſſumed by way of diſtinction, the name of *alchemiſts*, that is, *the chemiſts*, becauſe they conſidered themſelves, on account of the knowledge they poſſeſſed, more highly favoured than the reſt of mankind. It was natural enough for men who obſerved the remarkable changes produced by chemical action, to be ſtruck with their effects; and overlooking the variations and differences in the reſult of their operations, which were the conſequences of partial or inaccurate obſervation, to flatter themſelves that their power over the ſubſtances on which they operated, was only limited by their wiſhes. Hence, perhaps, originated all the extravagances and follies, ſimilar indeed to thoſe of ſpeculators and projectors of every age, with which the hiſtory and works of the alchemiſtical writers are filled. Many of the alchemiſts, it is not improbable, were the dupes of their own ignorance and credulity; but many more, there is little doubt, took advantage of the ignorance and barbarity which prevailed in the dark ages, during which period they chiefly flouriſhed, and impoſed on the weakneſs and credulity of mankind.

22
The alchemiſts.

It was one of the firſt principles among the alchemiſts, that all metals are compoſed of the ſame ingredients, or, that the ſubſtances which enter into the compoſition of gold, are found in all metals, but mixed with many impurities, from which, by certain proceſſes, they might be freed. The great, the conſtant object of all their labours and reſearches was the diſcovery of a ſubſtance poſſeſſed of the wonderful property of converting the baſer metals into gold, which, on account of its ſcarcity and durability, is more valued and eſteemed than the other metals, which are more abundant, and generally more uſeful. This celebrated ſubſtance was denominated the *philoſophers ſtone;* and thoſe who were ſo ſingularly fortunate as to accompliſh this great diſcovery, or thoſe to whom it was imparted by others, were regarded, as might naturally be expected, as the peculiar favourites of heaven. When they were in poſſeſſion of this grand ſecret, they were ranked among the higheſt order of alchemiſts, and then aſſumed the name of *adepts;* and thus initiated, they profeſſed themſelves maſters of the enviable ſecret of tranſmuting or changing metals of inferior value, into gold.

23
Philoſophers ſtone.

But the adepts never ſeem to have thought of enriching themſelves by their great diſcoveries. They were too generous to monopolize the wealth of the world. They accordingly offered their ſervices to others, and liberally propoſed to communicate the fruit of their labours for a moderate reward. The ambitious man to procure riches, that he might increaſe his power, and the opulent man to add to his wealth, eagerly ſought after, employed, and encouraged them in the proſecution of their extravagant ſchemes. They were therefore kept in the pay of princes, to fill and repair their exhauſted treaſuries, and of great men who aſpired after boundleſs wealth. Theſe flattering hopes, it may well be ſuppoſed, were never realized. The rich proſpect fled before them, and the golden prize which they often ſuppoſed was juſt within their reach, eluded their eager graſp. The magnitude of the plan, however, fired the imagination, and produced ſomething like conviction in the mind, of the poſſibility, and even certainty, of obtaining the object of all their wiſhes and all their labours. With unabating ardour, with unexampled aſſiduity, they purſued their reſearches, perſuading themſelves and their employers, that they were on the point of being ſoon in poſſeſſion of unlimited wealth.

But the alchemiſts beholding man by anticipation poſſeſſed of immenſe riches, ſaw that ſomething more was requiſite, that he might be ſecured in the uninterrupted enjoyment of them. Experience fatally taught them, that the feeble frame of man was liable to the pains and languor of diſeaſe; that gold and ſilver could neither prevent the fit of a fever, nor give to the poſſeſſor the bleſſings of conſtant health. Thus another moſt deſirable object was held up to view, and deluded their diſtempered minds into the falſe hope of attaining it. This was the famous *panacea*, or univerſal medicine, which was to cure all diſeaſes; and not only to cure, but abſolutely to prevent their occurrence. Thus fortunate in the enjoyment of vaſt riches, thus bleſſed with unbroken health, the deſires of man were yet unſatiſfied. Another ſeeming evil ſtill remained, which was naturally to be dreaded as the deſtroyer of this fancied ſcene of apparently perfect felicity. The melancholy reflection, that it was limited by the ſhort ſpan of human life, rouſed the alchemiſts again into exertion, and produced new efforts of ingenuity in their labours, to ſecure to man exemption from the common lot of mortality. In imagination they had diſcovered the means of prolonging life at pleaſure to an indefinite length, of reſcuing man from the grave, and of making him immortal upon earth.

24
Univerſal medicine.

Such were the extraordinary views and purſuits of the alchemiſts. The exact period of the origin of this ſtudy is unknown; nor can it now be aſcertained what progreſs it had made, or indeed whether it was at all cultivated among the ancients. Julius Firmicus Maternus is the firſt hiſtorian who mentions this ſtudy as well known in his day; and the period when he flouriſhed was about the beginning of the 4th century. A ſubſequent author, Æneas Blaſius, who lived in the following century, alſo makes mention of it: and Suidas defines the term by informing us, that it is the art of making gold and ſilver. Diocleſian, he ſays, prohibited all chemical operations, during his perſecution of the Chriſtians, that his ſubjects might not be inſtigated to acts of rebellion againſt him by the formation of gold. In ſome places where gold is waſhed down in minute particles, by brooks and rivulets from the mountains, it is cuſtomary to ſuſpend the ſkins of animals in the water, by which means the particles containing the gold are detained; a circumſtance from which the fabulous ſtory of the golden fleece probably derived its origin. Suidas, however, who flouriſhed in the 10th century, is not entitled to any high degree of credit, eſpecially as the ancient authors are wholly ſilent as to the ſubject of alchemy.

It is from the phyſicians of Arabia that we obtain the moſt ſatisfactory evidence concerning alchemy. Avicenna, who lived in the 10th century, is ſaid to have written on this ſubject, according to one of his own diſciples, who likewiſe takes notice of roſe-water and ſome other chemical preparations; and in the 12th century we find the cultivating an acquaintance with the chemiſts recommended to phyſicians. Another Arabian writer ſays, that the method of preparing roſe-water, &c. was at that time well underſtood. Theſe proofs of the exiſtence of alchemy among the Arabians, and particularly from the particle *Al* prefixed to it, have induced ſome to conclude, that the doctrine of the tranſmutation of metals firſt originated with the Arabians, which the cruſades were inſtrumental in introducing into Europe, as well as the rapid conqueſts of the Arabians, in Europe, Aſia, and Africa. At that period Europe was in a ſtate of the utmoſt barbarity, owing to the incurſions of the northern nations; but ſome of the ſciences, among which alchemy was comprehended, were happily revived by the Arabians: and about the middle of the 17th century, the extravagance of ſuch as were the profeſſors of alchemy arrived at its greateſt height.

25 Principal alchemiſts.

It appears that the alchemiſts began to be eſtabliſhed in the weſt of Europe, as early as the ninth century; and between the eleventh and fifteenth centuries, this ſtudy was in its moſt flouriſhing ſtate. Among the principal alchemiſts who flouriſhed during this period, and who were diſtinguiſhed for their diſcoveries and writings, were Albertus Magnus, Roger Bacon, Arnoldus de Villanova, and Raymond Lully. They all lived in the 13th century. Albertus Magnus was a Dominican monk of Cologne, and was regarded by his cotemporaries, no doubt on account of his ſtudies, as a magician. He was born in the year 1205, and died in 1280. He left numerous works, one of the moſt curious of which is a treatiſe entitled *De Alchemia*, which exhibits a diſtinct view of the ſtate of chemiſtry at the time he lived. Roger Bacon, another monk, was born in the county of Somerſet in England, in 1214, and died in 1294. He was celebrated for many ingenious inventions and diſcoveries in chemiſtry and mechanics. Among theſe are mentioned the *camera obſcura*, the *teleſcope*, and gunpowder. His works diſcover aſtoniſhing ſagacity and acuteneſs, and, conſidering the age in which he lived, are compoſed with no ſmall degree of elegance and conciſeneſs. Some of them, however, bearing the character of the times, are myſtical and obſcure. Arnoldus de Villanova, was a native of Languedoc in France, and was born about the year 1240. He has mentioned the mineral acids, and joined to his chemical ſtudies extenſive knowledge in medicine. His writings are diſtinguiſhed by all the obſcurity of the alchemiſtical authors. Raymond Lully, whoſe reputation raiſed him to the rank of *adept*, was born at Barcelona in 1235. He wrote on ſtrong waters and metals. His laſt will and teſtament is one of the moſt celebrated of his writings; and theſe are not leſs obſcure than thoſe of his cotemporaries.

About the end of the 14th century, Baſil Valentine, a German Benedictine monk, was the firſt who formally applied chemiſtry to medicine. He was the original diſcoverer of many of the virtues of antimonial medicines; and in his celebrated treatiſe on antimony, entitled *currus triumphalis antimonii*, are found many preparations which have ſince been announced to the world as new diſcoveries. About the ſame time lived Iſaacus Hollandus, whoſe works have been greatly commended by Boerhaave.

26 Paracelſus

27 the firſt public teacher of chemiſtry.

In the beginning of the 16th century aroſe Paracelſus, one of the moſt extraordinary men who ever lived. He was born in 1493, near Zurich in Switzerland. Of a bold and enterpriſing ſpirit, he deſpiſed the common rules of conduct by which men are uſually guided. By this means he raiſed his reputation to a great height; he became an enthuſiaſt in chemiſtry, and in the application of ſubſtances prepared by chemical proceſſes to the cure of diſeaſes. He was the firſt public teacher of chemiſtry in Europe, having been appointed to deliver lectures on that ſubject in the city of Baſil: but his reſtleſs ſpirit did not permit him to remain long in this ſituation. In two years he was involved in a quarrel with the magiſtrates, from whom he had received his appointment, and he left the city. Deſpiſing the common principles of medical practice, and having performed ſome wonderful cures by the free uſe of opium and of mercury, he thought he had diſcovered the univerſal medicine, and promiſed immortality to himſelf and to his patients. But while he thus made ſuch flattering promiſes, his own fate was a ſad proof of the futility and abſurdity of his doctrine. For after an almoſt uninterrupted courſe of debauchery, having wandered a great part of his life from place to place, he died at an inn in Saltzburg, in the 48th year of his age.

28 Alchemy declines.

29 Chemiſtry aſſumes the form of a ſcience.

A great number of medical practitioners, in the courſe of the 16th century, adopted and propagated the principles of Paracelſus. Among the moſt diſtinguiſhed of theſe was Van Helmont, a man of conſiderable genius, who was born in the year 1577. Many of the followers of Paracelſus were greatly devoted to the ſtudy of chemiſtry; and this, with the abſurd and unprincipled conduct of their maſter, tended not a little to bring the views and ſpeculations of the alchemiſts into diſrepute. Chemiſtry, now freed from the trammels of alchemy, conſiſted only of a number of detached, unconnected facts. To bring theſe facts together in one point of view, and to arrange them into claſſes, ſo that the knowledge of them might be applied to uſeful purpoſes, and to thoſe objects to which future reſearches might be advantageouſly directed, were now wanted. This taſk was accompliſhed by Beccher, who diſtinguiſhed himſelf by the extent of his views, in a work entitled, *Phyſica ſubterranea*, which was publiſhed at Frankfort in the year 1669. This was the firſt dawn of chemical ſcience, and the publication of Beccher's work formed an important æra in the hiſtory of its progreſs.

30 Diſcoveries of the alchemiſts.

In taking a retroſpective view of the progreſs of chemiſtry, previous to the publication of Becher's work, we find that a great number of important facts had been diſcovered and collected. To the claſs of acids, the ſulphuric, the nitric, and the muriatic, were added; the alkalies were better known, and the volatile alkali was obtained from ſal ammoniac by Baſil Valentine, by decompoſing it by means of ſoda or potaſs; the ſulphate of potaſs prepared in three or four different ways, received as many different names; the nitrate of potaſs was called nitre, a name which was formerly applied to ſoda; Sylvius diſcovered the muriate of potaſs, which he denominated digeſtive ſalt; and Glauber, the ſulphate of ſoda, to which he gave the name *wonderful ſalt*, though better known by the name of Glauber's ſalt, by which it is ſtill diſtinguiſhed. Some of the earthy ſalts began to be known about this period, and among others the muriate of lime, which received the name of fixed ſal ammoniac.

The earths themſelves were alſo better known; lime water was prepared, and ſome of the alkaline ſulphurets were pointed out and examined.

The properties of ſome of the metallic ſalts were ſtudied and examined; the nitrate of ſilver, under the name and form of *cryſtals of Diana*, and of *lapis infernalis;* the muriate of ſilver, under that of *luna cornea*. The two muriates of mercury were deſcribed, and employed for various purpoſes. The red precipitate, *arcanum corallinum*, *ſaccharum ſaturni* or ſugar of lead, the butter of antimony, and the powder of algaroth, were either diſcovered, or their properties more attentively inveſtigated and aſcertained.

During this period alſo, the diſtinction was made between the brittle and the ductile metals. Biſmuth, zinc, antimony, and even arſenic itſelf, were obtained in a metallic ſtate. A number of oxides, ſome metallic dyes, fulminating gold, turpith mineral, the ſaline precipitates of mercury, or the mercurial oxides of different colours, minium and litharge, colcothar, the ſaffron of Mars, and diaphoretic antimony, were diſcovered, and their preparation ſufficiently deſcribed.

During this period, the preparation of oils by diſtillation commenced, and the diſtinction was made between volatile and empyreumatic. Ethers were diſcovered, and the ſpirit of wine was well known by the ſame name, alcohol, which it at preſent bears.

31 Their hiſtory uſeful.

But however extravagant it may ſeem to us, the hiſtory of the alchemiſts is inſtructive, as it affords a uſeful leſſon to moderate our expectations in the purſuit of knowledge, and to reſtrain them within the bounds which the Almighty has preſcribed as the range of our inveſtigations; for of the knowledge and of the power of man, as well as of that of the natural elements, he has probably fixed the limits, and ſaid, Hitherto ſhalt thou come, but no farther. This hiſtory is inſtructive alſo, as it preſents a ſingular and extraordinary feature in the hiſtory of mankind; but it is immediately uſeful to our preſent purpoſe, as it ſhows us the commencement of chemical reſearches. It is true, chemiſtry in in the hands of the alchemiſts, like every other department of knowledge during the dark ages, was involved in myſtery, and the knowledge of it communicated in a barbarous jargon, to be underſtood only by the initiated, and ſcarcely to be decyphered and comprehended at the preſent day, with the aſſiſtance of the extenſive knowledge of chemical facts which we now poſſeſs. But notwithſtanding the extravagance of the objects they purſued, the means they employed were uſeful to the progreſs of chemiſtry. By their inceſſant labours, diſcovery was added to diſcovery, facts were multiplied on facts, but theſe were unaccompanied with any regular train of reſearch or reaſoning.

32 Their diſcoveries comparatively few.

But notwithſtanding theſe important diſcoveries, it may appear ſurpriſing that they were not more numerous. The alchemiſts had laboured inceſſantly in chemical purſuits for near a thouſand years, and with all the zeal and ardour of enthuſiaſts; the labour of whole lives was exhauſted, and immenſe fortunes were diſſipated in endeavouring to obtain the grand object of all their reſearches. Conſidering the long period during which they flouriſhed, and the numbers who were employed in theſe purſuits, there is indeed room for wonder, that they bequeathed to the firſt ſcientific inquirers ſo ſmall a ſtock of chemical knowledge. But the ſpirit which privailed among the alchemiſts was directly hoſtile to the free communication and accumulation of knowledge. The prominent feature of the character of the alchemiſts was ſecrecy. 33 The reaſon. This indeed was cloſely connected with the nature of the object, to attain which, all their purſuits and inquiries were directed; and ſo ſtrongly was this impreſſed upon their minds, that they believed, or pretended to believe, that the dreadful wrath of heaven would fall on him who ſhould preſume to diſcloſe to any, but to the initiated, the ſecrets of the art. That ſpirit, which aroſe from motives of avarice and ſelf-conceit, became at laſt one of the leading principles of their conduct. With ſo great, ſo important an object in view, as the diſcovery of the means of putting themſelves in poſſeſſion of unlimited wealth, it is little to be wondered at, if they ſhould carefully conceal from the world, and even from each other, the ſteps in the progreſs which led to the accompliſhment of this end. Thus, all their proceſſes were carried on in private, all their diſcoveries were kept ſecret. In their pretended communication of knowledge with each other, they employed certain ſigns and figures, and aſſumed a myſterious mode of writing, that they might be underſtood only by *adepts*, and might be totally unintelligible to the reſt of mankind.

Conſidering this ſpirit, and the character which diſtinguiſhed the alchemiſts, it was ſcarcely to be expected that they ſhould reveal to the world, either by ſpeech or writing, diſcoveries which moſt of them probably believed were to be of ſuch vaſt benefit to themſelves. And in this view, we ſhould rather be ſurpriſed that any of their proceſſes were ever made known. Bnt here vanity, and even avarice, probably had conſiderable influence in calling forth what they pretended was an account of their attainments and diſcoveries. Some of the alchemiſts, perhaps by means of trick and impoſture, had acquired a high reputation for knowledge, and had impoſed a belief on many, that they were actually in poſſeſſion of the philoſopher's ſtone. They were therefore ſought after, and often received great rewards for their labour, in proving the effects, or trying the ſucceſs of this wonderful agent. To be thus employed was perhaps the object of many in the publication of their works. But, at the ſame time, they cautiouſly avoided revealing their knowledge, by employing myſterious and metaphorical language. Thus we may account for the impenetrable obſcurity and numerous abſurdities which characterized their writings.

In this view, therefore, of the character of the alchemiſts, it is not to be expected that the ſtore of chemical facts could be very ample from their labours. And indeed, conſidering the caution with which they concealed and carried on all their proceſſes, it is not improbable that many important diſcoveries were never announced by the firſt obſervers; for the very appearance of any thing new or unexpected, would flatter their hopes that they had advanced another ſtep toward the attainment of their objects, and that the next would put them in full poſſeſſion of it. Thus, ſuch a diſcovery would be held inviolably ſecret, and in this way it might be loſt for ever.

34 Stahl improves the theory of Beccher.

We have already mentioned, that the work of Beccher gave the firſt ſcientific form to chemical knowledge. This appeared about the middle of the ſeventeenth century, when the light of knowledge began to ſpread over Europe, and chemiſtry received its ſhare. The facts which had been accumulated by the labours of the alchemiſts, and to which Beccher had given a ſyſtematic form, were ſtill farther methodized and extended by his pupil Stahl. Indeed, ſo much was done by the latter, in ſimplifying and improving the theory of his maſter, that it was afterwards denominated from his name the *Stahlian* or *phlogiſtic theory*. This theory was then received and adopted by all chemiſts, and continued to flouriſh for more than half a century.

35 Chemiſtry ſtudied in

36 Britain.

After the middle of the ſeventeenth century, the eſtabliſhment of philoſophical ſocieties in Europe greatly contributed to the diffuſion of knowledge. It was about this time that the academy of ſciences was eſtabliſhed in France, and ſome of its members roſe high in reputation by their experiments and diſcoveries in chemiſtry. The royal ſociety of London was alſo founded about the ſame period; but its members, after the example of Newton, were more occupied in mechanical philoſophy, and paid leſs attention to chemical ſcience. It was not, however, entirely overlooked. Newton himſelf threw out ſome important hints, and took ſome general views of chemical phenomena; Boyle, along with his reſearches in mechanical philoſophy, proſecuted the ſtudy of chemiſtry; and the experiments of Hooke and Mayow, on the nature of combuſtion and reſpirable air, diſcover a high degree of ſagacity and ſkill in their inveſtigations.

37 In France.

Towards the middle of the eighteenth century, the ſtudy of chemiſtry became general, and even faſhionable, in France. Before this time Homberg, Geoffroy, and Lemery, had diſtinguiſhed themſelves by their chemical experiments and diſcoveries. Among theſe Geoffroy is ſtill deſervedly celebrated for his invention of the tables of chemical affinities, an ingenious method of exhibiting, at one view, the principal reſults of experiments in this ſcience. Theſe tables were afterwards improved by ſeveral chemiſts, but eſpecially by Rouelle, Wenzel, and Bergman.

38 Black's diſcovery.

But the diſcovery of Dr Black formed one of the moſt important æras in the hiſtory of this ſcience, and gave a new and unexpected turn to the views of chemiſts. It was the object of Dr Black's reſearches to diſcover the cauſe of the remarkable change which a piece of limeſtone undergoes when it is calcined or burnt, and to point out the reaſon of the great difference of the properties of this ſubſtance in its different ſtates; and his inveſtigations were crowned with ſucceſs. For, in the year 1755, he aſcertained that theſe changes were owing to the combination or ſeparation of a peculiar kind of air, different in its properties from the air of the atmoſphere. When this air is combined with lime, it is in the mild ſtate, or the ſtate of limeſtone: when this air is driven off, which is the proceſs of calcination or burning, the limeſtone has changed its properties; it is reduced to the cauſtic ſtate, and has loſt conſiderably of its weight; and this loſs of weight, Dr Black proved, was exactly equal to the weight of the air which had been driven off. To this air Dr Black gave the name of *fixed air*; becauſe, when united to the lime and other ſubſtances, with which it enters into combination, it is in a fixed ſtate. This diſcovery, one of the moſt important in chemiſtry, opened a new field for inveſtigation; for it had not been once ſuſpected, that aerial ſubſtances formed combinations with ſolid bodies.

39 Other important diſcoveries.

From this time, the progreſs of chemiſtry was rapid and brilliant. Facts and diſcoveries were daily multiplied, and a ſpirit of enthuſiaſm for the ſtudy burſt forth, and was diffuſed far and wide. In the year 1774, Dr Prieſtley, who had contributed largely to the ſtock of chemical knowledge, diſcovered pure or vital air, and that this air only was fit for the purpoſes of reſpiration and combuſtion. In the year 1781 Mr Cavendiſh, another ingenious Engliſh chemiſt, proved that water is not a ſimple element, but that it is compoſed of pure or vital air, and inflammable air; or, in chemical language, of oxygen and hydrogen.

But, previous to this time, two chemiſts had appeared in Sweden, had diſtinguiſhed themſelves by their zeal, ingenuity, and indefatigable induſtry, and had merited and obtained the higheſt reputation for the valuable diſcoveries which they had made in chemical ſcience. Thoſe who are at all acquainted with the hiſtory of chemiſtry, need not be told, that theſe celebrated names are thoſe of Bergman and Scheele; names which will not be forgotten as long as modeſty, candour, and truth, are honoured and reſpected among mankind.

In the mean time, the French chemiſts were not idle. The celebrated Lavoiſier, in conjunction with ſome of his philoſophical friends, confirmed, by the moſt deciſive experiments, the truth of Mr Cavendiſh's diſcovery of the compoſition of water, which was now received and adopted by almoſt every chemiſt. The ſame unfortunate philoſopher, whoſe bright career was cut ſhort by the horrors of the French revolution, had, previous to the time alluded to, enriched chemical ſcience with many valuable and important facts. He had greatly contributed to overthrow the phlogiſtic theory, by a ſeries of accurate experiments and obſervations on the calcination of metals. It had now become a queſtion, whether metals, during the proceſs of calcination, gave out any ſubſtance; that is, whether they contained any phlogiſton; and Lavoiſier inconteſtably proved, that metals cannot be calcined, excepting in contact with pure air, and that the calx thus obtained was, in all caſes, exactly equal to the weight of the metal, and the quantity of air which had diſappeared.

40 New nomenclature.

Chemiſtry, by its rapid and unexampled progreſs, had now ſo far extended itſelf, and had accumulated ſo large a body of facts, that the barbarous, unmeaning, and arbitrary language which the alchemiſts employed to veil their myſteries, and part of which had been adopted and imitated in language equally obſcure and arbitrary by the earlier chemiſts, rendered it extremely difficult to be acquired or underſtood. This was loudly and juſtly complained of, but the difficulties in the way of remedying it ſeemed almoſt inſurmountable. The French chemiſts, however, undertook the arduous taſk, and completely ſucceeded in their labours. To theſe illuſtrious philoſophers we are indebted for the preſent language of chemiſtry, which is ſo conſtructed, that every word, and every combination, has an appropriate meaning, and is intended to expreſs the nature and compoſition of the ſubſtance which is repreſented It is to this improvement in its language, that we are to aſcribe the facility and preciſion with which the knowledge of chemiſtry can now be communicated, and which has undoubtedly contributed greatly to its general diffuſion and cultivation. And if there be any ground for hope of its future progreſs, from diſtinguiſhed talents, ardent zeal, and unceaſing induſtry, thoſe who are now engaged in the ſtudy of this ſcience, give fair promiſe of a rich harveſt.

SECT. IV. *Of the Firſt Principles of Bodies, and of the Methods of ſtudying and arranging them.*

41
Elements of bodies among the ancients.

1. According to the ancient philoſophers, all matter conſiſted of four principles or elements. Theſe were fire, air, water, and earth; and this opinion, with certain modifications, ſeems to have univerſally prevailed. But the diſcoveries of modern chemiſtry have proved, that three of theſe elements, at leaſt, are compound ſubſtances. Fire is a compound of light and heat; air is compoſed of oxygen and azotic gaſes; and water conſiſts of oxygen and hydrogen.

42
The alchemiſts.

The alchemiſts, not ſatisfied with this diviſion of the principles of bodies, adopted another, which was more appropriate to the nature of their labours and experiments, and was better calculated to explain the appearances with which they were acquainted. The elements of all bodies, according to their theory, were *ſalt*, *ſulphur*, and *mercury*: and theſe were long known among the alchemiſts by the appellation of the *tria prima*. Theſe principles were admitted by all the alchemiſtical writers till the time of Paracelſus, who alſo adopted them, and added two more to the number. Theſe five elements or principles are thus characterized. Every thing came under the name of *ſalt* which was ſoluble or ſapid; all inflammable ſubſtances were called *ſulphur*; and every volatile ſubſtance, which flies off without burning, was called *mercury* or *ſpirit*. What was liquid and inſipid was called *phlegm* or *water*; every thing that was dry, inſipid, fixed, and inſoluble, was called *earth*, or *caput mortuum*. The two laſt, which were added by Paracelſus, are the water and earth of the ancients. According to the original theory of the alchemiſts, all bodies may be decompoſed by fire, and reſolved into their three conſtituent principles. The mercury or ſpirit, during the proceſs of combuſtion, eſcapes in the form of ſmoke; the ſulphur is inflamed; and the ſalt, which was ſuppoſed to be the fixed principle, remains behind.

43
Beccher's elements.

But Beccher, whom we have already mentioned as the founder of chemical ſcience, perceiving the vague and unſettled notions of the alchemiſts, with regard to the principles of bodies, generalized and ſimplified ſtill more, the chemical facts which were then known. According to his theory, all bodies conſiſted of earth and water. Under the former he included every thing that was dry, and under the latter, whatever was humid. He admitted three earthy principles, namely, the fuſible earth, the inflammable earth, and the mercurial earth. The firſt was the principle of dryneſs, of infuſibility and hardneſs. The fuſible earth, combined with water, compoſed an acid, which was called the *univerſal acid*, becauſe all other acids owed their properties to it. The inflammable earth was conſidered as the principle of combuſtibility; and the mercurial earth was the principle of volatility. The fuſible and the mercurial earths, with water, compoſe common ſalt; and the inflammable earth, with the univerſal acid, forms ſulphur. The metals were compoſed of theſe three earths in equal proportions. When the mercurial earth was in ſmall proportion, the compound was *ſtone*; when the fuſible was in greater proportion, the compound was *precious ſtones*; and the compounds are the colorific earths, when the inflammable earth is in the greateſt, and the fuſible in the ſmalleſt proportion.

44
Stahl's.

This theory of Beccher was conſiderably modified by his pupil Stahl. The inflammable earth of Beccher ſeems to have been changed by him into the principle of inflammability or fixed fire, which he diſtinguiſhed by the name of *phlogiſton*. He admitted the univerſal acid, but rejected the mercurial earth. The number of elements in the theory thus modified by Stahl, amounted to five. Theſe were, *air*, *water*, *phlogiſton*, *earth*, and the *univerſal acid*.

This mode of conſidering the elements of bodies, or their firſt principles, and of admitting ſuch arbitrary and erroneous diſtinctions, is juſtly baniſhed from chemical ſcience. All ſubſtances are ſuppoſed to be ſimple, which have not been decompoſed, without regard to their primitive elements or principles, the knowledge of which is, perhaps, beyond the reach of human power ever to arrive at.

2. To acquire the knowledge of thoſe properties of bodies, inveſtigation of which is properly included under the chemical ſcience, two methods are employed: The one is the method of analyſis or decompoſition, the other is that of ſyntheſis, or compoſition. By the one, the different ſimple ſubſtances of which compound bodies conſiſt, are ſeparated, and their properties individually examined; by the other, the ſimple ſubſtances are combined together, and the properties of the new compound are conſidered and inveſtigated.

45
Analyſis.

Different kinds or modes of analyſis have been admitted and deſcribed by chemical writers. Some bodies, when expoſed to the action of heat and air, undergo a total ſeparation of their component parts. This is called *ſpontaneous* analyſis. Thus, ſome minerals, and all vegetable and animal matters, when they are deprived of life, in favourable circumſtances ſlowly ſeparate into their component parts; and in the ſame way the principles of which ſome liquids are compoſed, re-act on each other, and ſpontaneouſly ſeparate, which gives an opportunity of inveſtigating the nature of theſe ſubſtances.

Analyſis by fire operates by the accumulation of caloric in bodies; and by the power which it has of ſeparating their particles to favour their examination. But this inſtrument of analyſis is to be conſidered only as one of the means which ſhould concur with many others, to throw light on the real compoſition of bodies. For it will afterwards appear, that the different quantities of caloric accumulated in bodies, have the greateſt effects in giving different reſults, and changing the order of decompoſition.

Another mode of analyſis is by means of re-agents.

This is conducted by placing the compound body which is to be examined, in contact with various ſubſtances, which have the power of ſeparating its conſtituent parts. It is here that the genius and ſcience of the chemiſt appear moſt conſpicuous; for every ſubſtance in nature, and all the products of art, become valuable inſtruments in his hands, to aſcertain the nature, and to examine the properties, of the ſubſtances which come under his examination. The different means of analyſis which chemiſts have employed, to arrive at the knowledge of compound bodies, have been deemed of ſuch importance and utility, that chemiſtry has been called *the ſcience of analyſis*.

46 Syntheſis.

Syntheſis, or compoſition, is the union of two or more ſimple ſubſtances. This union, from whence reſults a new compound, has become an important ſtep in arriving at the knowledge of the properties of bodies, and in forming a number of products uſeful in the arts, and neceſſary to our wants; and thus it is conſidered by chemiſts as in ſome meaſure the inverſe of the method of analyſis, as the perfection of their art, and one of the great inſtruments of their operations. The method of ſyntheſis or compoſition, conſidered as a chemical proceſs to acquire the knowledge of the intimate and reciprocal action of bodies, is in reality more frequently employed than that of analyſis; and the name of the ſcience, if we were to regard theſe two methods, ſhould rather be called the *ſcience of ſyntheſis* than the ſcience of analyſis. In all caſes of complicated analyſis, the operations are ſynthetic. Compounds of an inferior order are formed, but more numerous than the firſt compounds which were ſubjected to analyſis or examination.

But beſides, there are many bodies which have never yet been decompoſed. It is only by compoſition or ſyntheſis, that is, by combining them with others, and by examining the nature of the compounds which are formed by this combination, that their chemical properties can be inveſtigated.

However various the operations of chemiſtry may be; however numerous and different from each other the reſults which are obtained; they may all be referred to analyſis or ſyntheſis, and be regarded either as combinations or decompoſitions; and to theſe two general methods, all our operations may be limited.

3. It muſt be univerſally allowed, that it is of vaſt importance, in acquiring or communicating knowledge, to have a clear view of the objects of our ſtudies; and this becomes the more neceſſary, as the facts in any ſcience are accumulated, and the objects which it comprehends become more numerous. In many of the arrangements of chemical knowledge which have been propoſed to the world, the objects of this ſcience have been claſſed together according to certain reſemblances in one or two points, while they are totally diſtinct in all others. But an arrangement which is founded on the properties and characters of ſubſtances which have not been fully aſcertained and generally admitted, muſt tend to obſtruct, rather than facilitate the acquiſition of ſcience. If, for inſtance, the objects of chemical knowledge are to be arranged according to their combuſtibility or incombuſtibility, the nature of the proceſs of combuſtion ſhould be fully underſtood, and the effect of combuſtion on the ſubſtances to be claſſed in this way, clearly eſtabliſhed. If all this has not been previouſly attended to, the principles of the arrangement muſt be falſe, and muſt unavoidably lead to error. As a proof of the truth of our remarks, the ſame ſubſtance has been conſidered by one chemiſt as a combuſtible body, while it is arranged by another among the claſs of incombuſtibles; and even by the ſame chemiſt it is ſaid to be combuſtible at one time, and incombuſtible at another, according to the theory which then prevails.

47 Arrangement.

Without purſuing any method of arrangement founded on particular theories or ſyſtems, we ſhall endeavour, in the following treatiſe, to lay before our readers a full view of the preſent ſtate of chemical ſcience; and in arranging the great body of facts of which the ſcience conſiſts, we ſhall obſerve the two following rules. 1. To introduce the ſubſtances to be examined according to the ſimplicity of their compoſition; and, 2. According to their importance as chemical agents. The plan which we propoſe to purſue, in treating of theſe different claſſes of bodies, is, 1. To conſider their properties as ſimple ſubſtances, and, 2. The combinations which they form with thoſe which have been already deſcribed. By this method of arrangement, and by following out this plan, we hope to have leſs anticipation and repetition than in moſt other ſyſtems which have yet been propoſed. But we wiſh not to think too confidently of our own labours. We ſhall probably be conſidered by the world as the worſt judges in this caſe; and we are not too ſelfiſh to ſubmit to the opinion of thoſe to whom it is addreſſed, to whoſe candour and impartiality we implicitly truſt. We may however, obſerve, that this arrangement has been found extremely convenient for teaching the ſcience; and we hope that our readers will find it equally ſo in acquiring the knowledge of it.

According to the principles which we have ſtated, the following table exhibits a view of the order which we ſhall obſerve in this treatiſe. In the preſent ſtate of chemical ſcience, and in its application to explain the phenomena of nature, or to improve the arts of life, the whole may be conveniently arranged into twenty chapters.

I. AFFINITY.
II. LIGHT.
III. HEAT.
IV. OXYGEN GAS.
V. AZOTIC GAS, AND ITS COMBINATIONS.
VI. HYDROGEN, &c.
VII. CARBONE, &c.
VIII. PHOSPHORUS, &c.
IX. SULPHUR, &c.
X. ACIDS, &c.
  1. Sulphuric,
  2. Nitric,
  3. Muriatic,
  4. Oxymuriatic, &c. &c.
XI. INFLAMMABLE SUBSTANCES.
  1. Alcohol,
  2. Ether,
  3. Oils.
XII. ALKALIES.
  1. Potaſh and its combinations,
  2. Soda, &c.
  3. Ammonia, &c.

XIII. EARTHS.
  1. Lime and its combinations,
  2. Barytes, &c.
  3. Strontites, &c.
  4. Magneſia, &c.
  5. Alumina, &c.
  6. Silica, &c.
  7. Yttria, &c.
  8. Glucina, &c.
  9. Zirconia, &c.
XIV. METALS.
  1. Arſenic and its combinations.
  2. Tungſten, &c.
  3. Molybdena, &c.
  4. Chromium, &c.
  5. Columbium, &c.
  6. Titanium, &c.
  7. Uranium, &c.
  8. Cobalt, &c.
  9. Nickel, &c.
  10. Manganeſe, &c.
  11. Biſmuth, &c.
  12. Antimony, &c.
  13. Tellurium, &c.
  14. Mercury, &c.
  15. Zinc, &c.
  16. Tin, &c.
  17. Lead, &c.
  18. Iron, &c,
  19. Copper, &c.
  20. Silver, &c.
  21. Gold, &c.
  22. Platina, &c.
XV. THE ATMOSPHERE.
XVI. WATERS.
  1. Sea water,
  2. Mineral waters.
XVII. MINERALS.
  1. Component parts,
  2. Analyſis.
XVIII. VEGETABLES.
  1. Functions,
  2. Decompoſition,
  3. Component parts.
XIX. ANIMALS.
  1. Functions,
  2. Decompoſition,
  3. Component parts.
XX. ARTS and MANUFACTURES.
  1. Soaps,
  2. Glaſs.
  3. Porcelain,
  4. Tanning,
  5. Dyeing,
  6. Bleaching.

48 explained.

In the above arrangement, the firſt chapter treats of affinity, or the laws of chemical action. In the two following chapters, the properties of light and heat are detailed. Theſe are conſidered as material ſubſtances; but their properties can only be known in combination with other bodies, as they have never been found in a ſeparate ſtate. Oxygen, azote, and hydrogen, which are conſidered as the baſis of oxygen, azotic, and hydrogen gaſes, are treated of in the 4th, 5th, and 6th chapters; but theſe ſubſtances, as well as light and heat, are not cognizable by our ſenſes. They are only known in a ſtate of combination, the aëriform or gaſeous ſtate, when they are combined with caloric, or the matter of heat. The three following ſubſtances, carbone, phoſphorus, and ſulphur, which are the ſubjects of the 7th, 8th, and 9th chapters, are conſidered as ſimple, becauſe they have never been decompoſed. They can be exhibited in the ſolid ſtate. Two of them being very abundantly diffuſed in nature, and entering into an immenſe number of combinations with other bodies; and the third, namely, phoſphorus, poſſeſſing very ſingular properties, it becomes of great importance that they ſhould be early known.

The acids are treated of in the 10th chapter. They are naturally arranged in this place, becauſe the conſtituent parts of ſome of the moſt important are derived from the ſubſtances which have been already treated of. But the properties of the claſs of acid bodies ought alſo to be early known, becauſe they are the moſt powerful inſtruments of analyſis in the hands of the chemiſt. Indeed ſuch is their importance in his inveſtigations, that in many of them he can ſcarcely proceed a ſingle ſtep without their aid.

The bodies treated of in the 11th chapter, namely, alcohol, ether, and oils, under the head of inflammable ſubſtances, are properly introduced, becauſe the nature and properties of the ſubſtances which enter into their compoſition have been previouſly examined; becauſe one of them is the reſult of a chemical action between the acids and alcohol; and becauſe ſome of them are employed as chemical agents. In the 12th, 13th, and 14th chapters, the properties and combinations of the alkalies, earths, and metals, are detailed. Excepting one, theſe three claſſes of bodies are ſimple, undecompounded ſubſtances. Many of them have long been the ſubjects of chemical inveſtigation, and they afford ſome of the moſt important and intereſting chemical reſearches. They are firſt to be treated of as ſimple ſubſtances; and next, as they enter into combination with the different claſſes of bodies which are already known, particularly with that of the acids, forming the numerous claſſes of alkaline, earthy, and metallic ſalts, moſt of which are of vaſt importance, not only as objects of chemical reſearch, but alſo of extenſive utility in the arts of life.

In the ſix following chapters, our chemical knowledge is to be applied in explaining the appearances of nature, ſo far as theſe are ſuppoſed to depend on chemical action. The 15th chapter treats of the chemical changes and combinations which take place in the atmoſphere. The waters, as they are found on the earth; the different ingredients with which they are impregnated; the nature and quantity of theſe ingredients, and the methods of diſcovering and aſcertaining them, form the ſubject of the 16th chapter. The 17th chapter is employed in giving a view of the component parts of mineral productions, and in deſcribing the methods of analyzing or ſeparating the parts which enter into their compoſition. The functions of vegetables and animals, or thoſe changes which take place in them in the living ſtate, which ſeem to be dependent on chemical action; the changes which they undergo by ſpontaneous analyſis, or ſeparation into their conſtituent parts, and the nature and properties of theſe elements, will be the ſubject of diſcuſſion in the 18th and 19th chapters. The 20th chapter, in which chemical ſcience is applied to the improvement of arts and manufactures, is not one of the leaſt important and intereſting, and a full view of this part of the ſubject would exhauſt the whole of the uſeful detail of chemical knowledge. But, in the following treatiſe, it is not propoſed to enter at full length into the different branches of the arts and manufactures, but only to give a ſlight view of their general principles, ſo far as they depend on chemiſtry, referring for the particular diſcuſſion of each to the different heads under which they will be found arranged in the courſe of the work.

Chap. I. Of AFFINITY.

Before we enter into the detail of thoſe changes which take place by the action of bodies upon each other, producing compounds which are poſſeſſed of totally different properties, and thus exhibiting the characters of chemical action, it is neceſſary to take a view of the circumſtances in which theſe changes are effected, or in other words, the laws of combination or chemical affinity.

49 Hiſtory.

The term *affinity*, which is the expreſſion of a force by which ſubſtances of different natures combine with each other, ſeems to have been pretty early employed by chemical writers. Barchuſen, it would appear, is among the firſt who employed it, and thus characterizes it. "Arctam enim atque reciprocam inter ſe habent affinitatem." It was afterwards brought into more general uſe, and its application more preciſely defined by Boerhaave *. His words are remarkable. "Particulæ ſolventes et ſolutæ, ſe affinitate ſuæ naturæ colligunt in corpora homogenea." And to explain his meaning ſtill more clearly, he adds, "non igitur hic etiam actiones mechanicæ, non propulſiones violentæ, non inimicitiæ cogitandæ, ſed amicitia." To avoid the metaphorical expreſſion *affinity*, Bergman propoſed the term *attraction*; and to diſtinguiſh chemical attraction, which exiſts only between particular ſubſtances, from that attraction which exiſts between all the bodies in nature, he prefixed the word *elective*. The word affinity, however, is now generally adopted, and employed by all chemiſts.

The different tendency of bodies to combine with each other, or the relative degree of affinity which exiſts between them, could not long be overlooked by thoſe whoſe attention was occupied in obſerving chemical changes. And to explain this difference of action, a maxim of the ſchoolmen was adopted; *ſimile venit ad ſimile*. 50 Its action explained. The ſame doctrine was held by Becher, that ſubſtances which were capable of chemical combination, poſſeſſed a ſimilarity of particles. Other attempts were made to explain chemical action, by conſidering ſolvents as conſiſting of points, finer or coarſer, which were mechanically diſpoſed to enter into the pores of certain ſubſtances which they were capable of holding in ſolution. But Stahl, as appears from his works, rejected the notion of mechanical force, and aſcribes the power of ſolvents to contact, or 51 by Stahl. to the attraction of coheſion. "Combinationes quaſcunque non aliter fieri, quam per arctam appoſitionem." And afterwards, he ſpeaks ſtill more preciſely when he ſays, "non per modum cunei, neque per modum incurſus, in unam particulam ſeparandam, ſed potius per modum apprehenſionis, ſeu arctæ applicationis;" and then he adds, "eſt inde rationi quam maxime conſentaneum, quod effectus tales potius arctiore unione ſolventis cum ſolvente contingant, quam nuda et ſimplici formali inſtrumentali diviſione †."

Having made this important ſtep in the conſideration of chemical action, the experiments and obſervations of the ſagacious chemiſt led him to conclude, that a combination between two ſubſtances once formed, could not be deſtroyed, without effecting a more intimate union of one of the conſtituent parts with ſome other ſubſtance.

52 Tables invented,

The next ſtep in the method of obſerving and ſtudying chemical affinity was made by Geoffroy the elder. He collected the ſcattered facts, to determine the force or meaſure of their degrees of union, and to eſtabliſh rules of analyſis and compoſition. His firſt table of affinity was preſented to the Royal Academy of Sciences at Paris in the year 1718. This conſiſted only of 17 columns, which were but imperfectly filled up, and exhibited rules which have been moſtly changed; but with all its errors, it ought to be conſidered as one of the firſt guides to chemical knowledge.

55 enlarged,

The firſt material improvement on Geoffroy's table was made by Gellert, profeſſor at Freyberg. In his *Chemia Metallurgica*, publiſhed in 1750, there is a new table of affinity, which extends to 28 columns. At the bottom of each column there is a liſt of ſubſtances with which the body at the head of the column had no action. Rudiger, in the year 1756, inſerted a table of affinity in his ſyſtem of chemiſtry, in which he reduced the number of columns to 15. In this table he placed the fixed alkalies and lime parallel with each other, and before ammonia, the column of acids. 54 and improved He pointed out alſo with a good deal of accuracy, in a ſmall ſeparate table, thoſe ſubſtances which refuſe to combine without ſome intermediate ſubſtance.

55 by Limbourg.

The next important addition to the knowledge of affinities, was made by M. Limbourg. In his table the number of columns was extended to 33. This table was the fulleſt and moſt accurate of any that had yet appeared. He had juſtly obſerved that zinc, of all metallic ſubſtances, ſhould be placed at the head in the column of acids, and that even in the dry way it precipitated them all. He aſſerted that lime and the cauſtic alkalies acted by affinity on animal matters; and beſides, he ſtated ſome caſes in which a change took place in the order of affinities, by a change of temperature, or by the volatility of one of the ſubſtances.

56 y Bergman.

This ſubject, the importance of which was ſufficiently obvious, was now aſſiduouſly inveſtigated by many chemiſts. The number of tables was multiplied, and the ſyſtem of affinity more fully eſtabliſhed. But the greateſt improvement which it had hitherto received, was made by the celebrated Bergman, in his diſſertation on elective attractions, publiſhed in the Tranſactions of the Royal Society of Upſal, in the year 1775. Theſe tables, editions of which appeared in 1779 and 1783, have been juſtly regarded as ſtriking inſtances of the ſagacity and induſtry of the author. The affinities of 59 ſubſtances are aſcertained with great accuracy; and the diſtinction between thoſe that take place in the moiſt and dry way, is particularly ſtated, as well as the diſtinction between ſimple and compound

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* *Elem. Chem.* part 2.

† *Specim. Becher.* ſect. 1.

affinities, which has led to the explanation of a great number of apparent anomalies. Since the time of Bergman, this ſubject has been proſecuted by many of the moſt diſtinguiſhed philoſophical chemiſts. Among theſe we may mention the induſtrious and indefatigable Kirwan of our own country; and among the French philoſophers, Morveau, and more eſpecially Berthollet, diſtinguiſhed for his ſkill and ſagacity, who has lately, in his reſearches concerning the laws of affinity, opened a new field of inquiry, corrected many former errors, and pointed out ſome new laws in this intereſting and important ſubject.

57
All bodies attract.

All bodies with which we are acquainted, are influenced by a certain force, by which they are attracted, or drawn towards each other. A ſtone, when it is unſupported, falls to the ground; the planets are attracted by the ſun; two poliſhed plates of metal, of glaſs, or of marble, when brought into cloſe contact, adhere with a certain force; a piece of wood or ſtone requires a conſiderable degree of force to ſeparate the particles, or to draw it aſunder; and lime and ſulphuric acid enter into ſuch cloſe combination, that it requires an equal degree of force to overcome that combination, or to ſeparate the particles from each other. Whatever may be the nature of theſe attractions, or the cauſe of theſe different combinations, or whether they are to be aſcribed to the ſame univerſal law pervading matter, as ſome have ſuppoſed, they have been deſcribed by philoſophers under different names. The attraction which exiſts between all bodies in the ſolar ſyſtem, was denominated by Newton, by the general term *attraction*; and he demonſtrated that this uniform and univerſal law was preciſely the ſame as the law of gravitation, or the deſcent of heavy bodies towards the earth; and that this attraction was an eſſential property of all matter; that the minuteſt particles, in proportion to their bulk, were equally influenced with the largeſt maſſes; that the ſame power which retained the planets in their orbits, gave form to the drops of rain.

58
Different names of affinity.

We have ſaid, that theſe different forces or attractions have been diſtinguiſhed by different names. That attraction which is exerted between two poliſhed ſurfaces brought into contact, has been called *adheſion*. When particles of the ſame nature are attracted or held together, the expreſſion of the force by which this is effected, has received the name of *coheſion*, *homogeneous affinity*, or the *attraction of aggregation*; but when diſſimilar particles, or the particles of two ſubſtances of different qualities combine together, the force or attraction which is here exerted has been called *heterogeneous affinity*, *the attraction of compoſition*, or, ſtrictly ſpeaking, *chemical affinity*. In the three following ſections, we propoſe to give an account of the opinions and doctrines which have been held by philoſophers with regard to the nature and force of theſe attractions. Of the two firſt we ſhall only take a ſhort view; but ſhall enter more fully into the detail of the latter, namely, chemical affinity, which more ſtrictly belongs to our preſent ſubject.

SECT. I. *Of ADHESION.*

By adheſion, then, is to be underſtood, that force which retains different ſubſtances in contact with each other. Thus, water adheres to the finger, which is ſaid to be wet, and mercury brought into contact with gold, adheres with great force. Adheſion takes place, either between two ſolids, as marble or glaſs; or between ſolids and fluids, as when water riſes in capillary tubes; or between two fluids, as water and oil. In an experiment made by Dr Deſaguliers, he obſerved, that two plates of glaſs, of one-tenth of an inch in diameter, adhered with a force equal to 19 ounces. The adheſion of two fluids has been proved by the experiment of Lagrange and Cigna, as that of oil and water, between which it was formerly ſuppoſed there exiſted a natural repulſion; and the experiments on capillary attraction, and particularly the aſcent of water between two panes of glaſs, which was aſcertained by Dr Brook Taylor, have eſtabliſhed the attraction between ſolids and fluids.

59
In what circumſtances it happens.

60
Accounted for.

This adheſive force, or the cauſe of this attraction, has been differently accounted for by philoſophers. In a diſſertation on the weight of the atmoſphere, publiſhed in 1682 by James Bernouilli, he aſcribes the reſiſtance which two poliſhed pieces of marble oppoſed to their ſeparation to the preſſure of the air; and in proof of this, he ſtates as a fact, that the two plates could be eaſily ſeparated *in vacuo*. But it has been ſuppoſed that he had either never attempted to verify this fact, or that the experiment had been accompanied by ſome fallacy. From the experiments made by Dr Taylor, he concluded that the intenſity of the adheſive power of ſurfaces might be meaſured by the weight which was required to ſeparate them. About the ſame time Mr Hawkſbee proved by experiment, that the adheſion of ſurfaces and capillary attraction were not to be aſcribed to the preſſure of the atmoſphere, as Bernouilli had ſuppoſed; but Lagrange and Cigna, after having proved the adheſion between oil and water, thought that it was owing to a different cauſe from that of attraction. They ſuppoſed that it was occaſioned by the preſſure of the air, and that the opinion of Dr Taylor was not well founded. Such were the opinions held by philoſophers on this ſubject, when Morveau, in the year 1773, was led to inſtitute a ſeries of experiments on adheſion, which he exhibited at Dijon. By theſe experiments he proved, that this attraction was not owing to the preſſure of the air, but entirely to the attraction of the two ſubſtances between themſelves. To prove this, a poliſhed plate of glaſs was ſuſpended from the arm of a balance, and placed in contact with a ſurface of mercury. The weight neceſſary to ſeparate the two ſurfaces was equal to nine gros and ſome grains. The whole apparatus was placed under the receiver of an air-pump, which was exhauſted of the air as much as poſſible. It required exactly the ſame force to ſeparate the ſurfaces. The ſame diſk of glaſs brought into contact with pure water, adhered to it with a force equal to 258 grains; but from the ſurface of a ſolution of potaſh, it required only a force of 210 grains. This inequality of effects with equal diameters, and in the inverſe order of the reſpective denſities, ſeemed not only to be deciſive in favour of Dr Taylor's method, but appeared to point out the poſſibility of applying it to the calculation of chemical affinities. For the force of adheſion being neceſſarily proportional to the points of contact, and the ſum of the points of contact not varying in the adheſion of a fluid and a ſolid with equal ſurfaces, but by the figure of their conſtituent parts, the difference of the reſults points out to us preciſely a cauſe analogous to that which produces affinity, the force of which it becomes eaſy, in theſe circumſtances, to meaſure and compare.

61 Morveau's experiments.

To aſcertain the accuracy of this method, plates of the different metals, of an inch in diameter, and of equal thickneſs, perfectly round, and well poliſhed, were procured. They were furniſhed, each with a ſmall ring in the centre, to keep them ſuſpended parallel to the horizon. Each of the plates was ſuſpended in turn to the arm of an aſſay balance, and exactly counterpoiſed by weights in the oppoſite ſcale. Thus balanced, the plate was applied to the ſurface of mercury in a cup, by ſliding it over the mercury in the ſame manner as is practiſed for ſilvering mirrors, to exclude the whole of the air. Weights were then put into the oppoſite ſcale, till the adheſion between the plate and the mercury was broken. In each experiment freſh mercury was employed. The following table exhibits the reſults of theſe experiments.

	Grains.
Gold adheres to mercury with a force equal to	446
Siver	429
Tin	418
Lead	397
Biſmuth	372
Zinc	204
Copper	142
Antimony	126
Iron	115
Cobalt	8

In conſidering the remarkable differences, it muſt appear that the preſſure of the atmoſphere has no influence, ſince its effects muſt have been preciſely ſimilar; nor do they depend on the difference of poliſh on the ſurface; for a plate of iron, ſimply ſmoothed and filed, adheres more ſtrongly than a plate of the ſame diameter which has received the higheſt poliſh. Nor are theſe differences owing to the difference of denſity; for in this caſe ſilver ſhould follow lead; cobalt would adhere with a greater force than zinc, and iron greater than that of tin. On the contrary, the order of their denſities is reverſed. What then is the order in which the adheſion of theſe different ſubſtances takes place? It is preciſely, ſays Morveau, the order of affinity, or the degrees of the greater or leſs ſolubility of the metals for mercury. Gold, of all the metals, attracts mercury moſt ſtrongly; but mercury diſſolves neither iron nor cobalt, and therefore they are placed at the bottom of the liſt. This correſpondence, he farther obſerves, cannot certainly be the effect of chance, but that it clearly depends on the general property of matter called attraction. This property which is always the ſame, and always ſubject to the ſame laws, produces very different effects, according to the different diſtances between the particles occaſioned by the variety of elementary forms; and that thus it may be poſſible to eſtimate the force of chemical affinity by the force of adheſion. In the preſent caſe, for inſtance, the real affinities which tend to combine mercury with gold, ſilver, zinc, and copper, may be expreſſed by the above numbers 446, 429, 204, and 142.

62 Achard's.

Achard of Berlin, convinced by Morveau's experiments, of the accuracy of Dr Taylor's method, ſaw its importance in chemiſtry; and having examined the principle, made a great number of applications of it, which he publiſhed in 1780. The reſult of theſe obſervations, if accurately obtained, can alone guide us in eſtimating the points of contact by adheſion, and by calculating the points of contact, to aſcertain the figure of the particles which touch, and the reſulting affinities. Three eſſential conditions are neceſſary for the accuracy and uniformity of each experiment. 1. That the ſolid body whoſe adheſion with a fluid is to be eſtimated be ſo ſuſpended as to be in a horizontal poſition, and that the force employed to detach it, ſhould always act in a line which forms a right angle with the ſurface of the fluid. 2. That there be no air interpoſed between the ſurface of the ſolid and the fluid: and, 3. That the weights employed as a counterpoiſe may be added, eſpecially towards the end, in very ſmall quantity, not more than a quarter of a grain each; and to avoid any ſudden jerk, they ſhould be placed gently in the ſcale.

63 Requiſites.

The firſt point which he wiſhed to aſcertain was, whether the difference of atmoſpherical preſſure, the temperature remaining the ſame, cauſed any difference in the adheſion of ſurfaces. For he found that the adheſive force between a plate of glaſs and diſtilled water was the ſame at all preſſures, but the uniformity of the reſults varied when he operated at different degrees of temperature, while the elevation of the barometer continued the ſame; and he found that this variation did not ariſe from the different temperatures of the ſurrounding air, but from that of the water. When the fluids are colder, the adheſion is the ſtronger; and the reaſon is obvious: as they contain more matter under the ſame volume, they ought to preſent a greater number of points of contact in the ſame ſpace; and ſince the force of the adheſion is in proportion to the number of the points of contact, it ought to increaſe when the fluids are condenſed by cold, and to diminiſh when they are rarefied by heat. Achard did not ſtop by obſerving theſe variations of the force of adheſion between glaſs and water heated to different temperatures; he ſubjected them to calculation, to verify his obſervations, and render their application eaſy to all degrees. The following table exhibits the force of adheſion by obſervation, and alſo by calculation. He proceeded on the following data.

Let x be the temperature of the water, y the correſponding adheſion, b its coefficient, and a the conſtant force. We have then the equation $x=a-by$. To find the value of a and b, he employed two obſervations; the one in which water at 104° of Sulzer's thermometer, adhered to the glaſs diſk with a force equal to 80 grains, and the other in which water at 56° adhered with a force equal to 89 grains. Proceeding from theſe two terms

$$104^\circ=a-80\,b$$
$$56=a-89\,b,$$

we have

$$a=530$$
$$b=\frac{-48}{9}$$

And thus the relation of the temperature of water to its adheſion to glaſs may be thus expreſſed: $x=530-\frac{48}{9}y$; and from thence are deduced the correſponding values of x and y for all the adheſions of glaſs to water at any temperature. Such are the data from which and the correſponding experiments, Achard formed the

the table which exhibits the adheſive force of a glaſs diſk of 1½ inch in diameter, to water at different temperatures; and ſhewing the difference of the reſults.

64
Adheſion of glaſs to water.

TABLE I.

Degrees of Sulzer's Therm.	Degrees of Fahren. Therm.	Adheſion by Experiment.	Adheſion found by Calculation.	Difference.
95	141.687	81.25 grs.	81.55	—0.3
90	135.914	82.5	82.5	0
85	130.141	83.75	83.43	+0.34
80	124.368	84.5	84.37	+0.13
75	118.595	85.75	85.31	+0.46
70	112.822	86.	86.25	—0.25
65	107.049	87.25	87.18	+0.07
60	101.276	88.5	88.12	+0.38
55	95.503	89.	89.06	—0.06
50	89.730	90.25	90.	+0.25
45	83.957	90.75	90.93	—0.16
40	78.184	92.	91.87	+0.13
35	72.411	92.75	92.81	—0.04
30	66.638	93.75	93.73	+0.02
25	60.865	94.5	94.68	—0.18
20	55.092	95.75	95.62	+0.13
15	49.319	96.25	96.56	—0.31
10	43.546	97.5	97.5	0

The temperature being ſuppoſed to continue the ſame, if this principle be well founded, the force of adheſion of any given body with water, ought not only to increaſe or diminiſh according to the extent of ſurface, but theſe differences ought to be as the difference of the ſurfaces.

If then p be the force with which a diſk of glaſs whoſe diameter is a, adheres to water, and y the force of adheſion of another diſk, whoſe diameter is b, we ſhall have the proportion $a^2 : b^2 :: p : y$ and $y = \frac{b^2 p}{a^2}$

To verify the order of this progreſſion, either with water or other fluids, Achard employed diſks of glaſs from 1½ to 7 inches in diameter, having firſt aſcertained their force of adheſion with theſe fluids, by the number of grains which were neceſſary to overcome it. He afterwards calculated the ſame by the above equation. The following Table exhibits the reſults of experiment and of calculation, which, if the procedure be free from error, correſpond as nearly as could be expected.

65
To different fluids.

TABLE II.

The force of adheſion between glaſs diſks of different diameters, and different kinds of fluids, determined by experiment and calculation.

Diameter of the Diſk.	Diſtilled water.		Alcohol.		Liquid ammonia.		Solution of potaſh.		Oil of Turpentine.		Linſeed oil.	
Inches	Experim. grs.	Calcul. grs.	Exper. grs.	Calcul. grs.	Experim grs.	Calcul. grs.	Experim. grs.	Calcul grs.	Experim. grs.	Calcul. grs.	Experim. grs.	Calcul. grs.
1.5	364.		216.		328.		420.		240.		268.	
1.75	494.5	49.5	294.25	294.	447.	446.	571.	571.	326.5	326.	363.25	364.
2.	647.25	647.	384.	384.	582.	583.	746.	746.	425.	426.	475.	476.
2.25	818.75	819.	457.5	457.	738.	738.	945.	945.	539.	540.	604.	603.
2.5	1010.	1011.	600.	600.	912.	911.	1167.	1166.	667.	666.	744.	744.
2.75	1225.5	1223.	725.	726.	1103.	1102.	1410.75	1411.	806.	806.	901.	900.
3.	1457.	1456.	863.25	864.	1311.5	1312.	1680.5	1680.	961.	960.	1072.25	1072.
3.25	1709.	1708.	1015.	1014.	1538.25	1539.	1970.	1971.	1126.5	1126.	1259.	1258.
3.5	1981.5	1982.	1177.	1176.	1786.	1785.	2287.	2286.	1305.75	1306.	1458.5	1459.
3.75	2257.	2257.	1350.	1350.	2049.	2050.	2624.5	2625.	1500.	1500.	1675.25	1675.
4.	2587.	2588.	1538.	1536.	2332.	2332.	2986.	2986.	1707.	1706.	1905.	1905.
5.	4044.	4044.	2399.	2400.	3645.	3644.	4665.8	4666.	2666.	2666.	2977.	2977.
6.	5824.5	5824.	3455.5	3456.	5248.25	5248.	6721.	6720.	3839.5	3840.	4289.25	4288.
7.	7926.25	7927.	4703.	4704.	7143.	7143.	9146.	9146.	5227.	5226.	5835.75	5836.

Achard alſo inſtituted a ſeries of experiments with different ſolid ſubſtances, formed into diſks of equal diameters, and applied to the ſurface of different fluids. The following table ſhows the reſults of theſe experiments; but from theſe reſults it appears, that the force of adheſion does not depend on the ſpecific gravity, either of the ſolid or the fluid; nor does it correſpond with the order of chemical affinities. But beſides, ſome of the reſults cannot be admitted as perfectly legitimate, on account of the chemical action which would neceſſarily take place when ſome of the ſubſtances were brought into contact; as ſome of the metals would be acted on by the acids, and others by the ſolutions of metallic ſalts.

TABLE III.

The force of adheſion of different ſolids, in diſks 1.5 inch in diameter, with water and other fluids, at 70° Fahrenheit's thermometer, determined in grains.

66
Of different ſolids to different fluids.

SOLIDS. FLUIDS.	Diſtilled water.	Sulphuric acid.	Concentrated vinegar.	Alcohol.	Acetite of lead.	Acetite of copper.	Deliquated potaſh.	Liquid ammonia.	Sulphuric ether.	Oil of turpentine.	Oil of almonds.
Specific gravity.	1000.	1868.4	1019.4	842.	1131.5	1000.	1368.4	1046.	828.9	881.5	907.8
Plate-glaſs -	91.	115.	87.	54.	98.	96.	105.	82.	54.5	60.	66.
Rock cryſtal	90.	112.	86.	52.	98.75	95.	103.	80.	53.	58.5	66.
Green oriental jaſper		96.	120.5	96.25	99.8	88.5	91.	122.	85.5	84.	56.5
Gypſum -	80.	199.75	78.	46.5	87.25	85.	93.	71.	48.	52.5	56.5
Sulphur -	965.	123.	92.5	58.	107.	101.5	110.5	86.	57.5	64.	69.
Yellow wax -	97.	120.5	92.75	56.5	106.5	103.	111.	88.	59.	64.	71.
Ivory - -	90.	114.	90.	92.	84.	86.	113.	80.	77.5	52.	
Horn - -	84.	104.75	85.	83.75	76.25	81.	106.	74.5	73.	48.75	
Iron - -	93.5	116.	88.	56.	104.	98.25	108.	83.5	55.5	61.	68.
Copper - -	96.5	123.	92.	57.25	106.	102.	112.	87.	58.	62.5	68.85
Tin - -	94.5		91.	55.5	103.5	100.	108.5	86.	54.75	61.	69.
Lead - -	100.25	129.25	98.	59.	111.	107.	115.	91.5	61.	67.	72.
Braſs - -	99.	124.	96.	59.	110.	103.5	114.	90.	60.	65.	70.5
Zinc - -	96.		90.25	57.	106.25	102.	110.	85.75	56.75	61.25	69.

From all theſe obſervations, then, we may conclude, that the force of adheſion between different bodies is altogether independent of the preſſure of the air; that it varies according to the number of points of contact of the touching ſurfaces; and that it is probably owing to the ſame cauſe as the force of affinity. It appears alſo, that the force of adheſion between ſolids and fluids is in the inverſe ratio of the temperature indicated by the thermometer, and the direct ratio of the ſquares of their ſurfaces; that different ſolids adhere with different degrees of force to the ſame fluid; but ſtill it muſt be allowed, that experiments and obſervations are yet wanting, to derive any advantage from the reſults of adheſive force which have been obtained, in the cultivation of chemical affinities.

SECT. II. *Of the Attraction of AGGREGATION.*

That force which is inherent in the particles of matter, by which they are held together, and form maſſes, is called *coheſion;* and when particles of the ſame kind are united together, it is denominated the *attraction of aggregation*, or *homogeneous affinity*. It is probably the ſame in kind with that which we have already conſidered,

ſidered, but differing in degree. Thus, it requires a much greater force to ſeparate the particles of a maſs of marble, than two poliſhed ſurfaces of the ſame ſubſtance brought into contact.

68 Difference of force. As the force of coheſion oppoſes itſelf to chemical action, ſo that the chemiſt in his reſearches is obliged to deſtroy or overcome it; it becomes a matter of conſiderable importance to be able to eſtimate it. This force is very different in different bodies. A very great force is neceſſary to overcome the power of coheſion among the particles of an iron or gold wire, while a ſmall degree of force can ſeparate the particles of a piece of wood or ſtone. To aſcertain this force, experiments have been made by different philoſophers, and particularly by Muſchenbroeck, on that of the coheſion of ſolid bodies. A rod of the ſubſtance whoſe coheſive force was to be eſtimated, was ſuſpended perpendicularly, and weights attached to the lower extremity. The weight neceſſary to deſtroy the coheſive force of the particles of matter in the rod, or to tear it aſunder, was conſidered as the meaſure of that force. The following are the reſults of his experiments made on different ſubſtances. The ſubſtances employed were rods of an inch ſquare, and the numbers in the table indicate pounds avoirdupois.

METALS.

Steel, bar	135,000
Iron, bar	74,500
Iron, caſt	50,100
Copper, caſt	28,600
Silver, caſt	41,500
Gold, caſt	22,000
Tin, caſt	4,440
Biſmuth,	2,900
Zinc,	2,600
Antimony,	1000
Lead, caſt,	860

ALLOYS OF METALS.

Gold 2 parts, ſilver 1 part,	28,000
Gold 5, copper 1,	50,000
Silver 5, copper 1,	48,500
Silver 4, tin 1,	41,000
Copper 6, tin 1,	55,000
Braſs,	51,000
Tin 3, lead 1,	10,200
Tin 8, zinc 1,	10,000
Tin 4, antimony 1,	12,000
Lead 8, zinc 1,	4,500
Tin 4, lead 1, zinc 1,	13,000

WOODS.

Locuſt tree,	20,100
Jujeb,	18,500
Beech and oak,	17,300
Orange,	15,500
Alder,	13,900
Elm,	13,200
Mulberry,	12,500
Willow,	12,500
Aſh,	12,000
Plum,	11,800
Elder,	10,000
Pomegranate,	9,750
Lemon,	9,250
Tamarind,	8,750
Fir,	8,330
Walnut,	8,130
Pitch pine,	7,656
Quince,	6,750
Cypreſs,	6,000
Poplar,	5,500
Cedar,	4,880

BONES.

Ivory,	16,270
Bone,	15,250
Horn,	8,750
Whalebone,	7,500
Tooth of ſea-calf,	4,075

69 Opinions on the nature of coheſion. Various opinions have been entertained of the nature of this coheſive force. According to Newton, as we have already obſerved, it is properly eſſential to all matter, and the cauſe of the variety obſerved in the texture of different bodies. 70 Newton's. "The particles," ſays he, "of all hard homogeneous bodies which touch one another, cohere with a great force; to account for which ſome philoſophers have recourſe to a kind of hooked atoms, which, in effect, is nothing elſe but to beg the thing in queſtion. Others imagine that the particles of bodies are connected by reſt; that is, in effect, by nothing at all; and others by conſpiring motions, that is, by a relative reſt among themſelves. For myſelf, it rather appears to me, that the particles of bodies cohere by an attractive force, whereby they tend mutually towards each other: which force, in the very point of contact, is very great; at little diſtances is leſs, and at a little farther diſtance is quite inſenſible."

71 Deſaguliers's. "If compound bodies," Dr Deſaguliers obſerves, "be ſo hard as by experience we find ſome of them to be, and yet have a great many hidden pores within them, and conſiſt of parts only laid together; no doubt thoſe ſimple particles which have no pores within them, and which were never divided into parts, muſt be vaſtly harder. For ſuch hard particles gathered into a maſs, cannot poſſibly touch in more than a few points; and therefore much leſs force is required to ſever them, than to break a ſolid particle whoſe parts touch throughout all their ſurfaces, without any intermediate pores or interſtices. But how ſuch hard particles only laid together, and touching only in a few points, ſhould come to cohere ſo firmly, as in fact we find they do, is inconceivable; unleſs there be ſome cauſe by which they are attracted and preſſed together. Now, the ſmalleſt particles of matter may cohere by the ſtrongeſt attractions, and conſtitute larger, whoſe attractive force is feebler: and again, many of theſe larger particles cohering, may conſtitute others ſtill larger, whoſe attractive force is ſtill weaker; and ſo on for ſeveral ſucceſſions, till the progreſſions end in the largeſt particles on which the operations in chemiſtry, and the colours of natural bodies, do depend; and which, by cohering, compoſe bodies of a ſenſible magnitude."

72 Boſcovich's. A theory, which poſſeſſes great ingenuity and plauſibility, has been propoſed by Boſcovich, to account for coheſive attraction; and ſome ſuppoſe, that it is on

immaterial means or powers that this attraction, according to this theory, depends. Dr Hutton * ſeems to think, that Dr Prieſtley applies it in this view, in the following paſſage, in which he attempts to ſolve ſome difficulties with regard to the Newtonian doctrine of light. "The eaſieſt method," ſays Dr Prieſtley, ſpeaking of this ſubject, "of ſolving all difficulties, is to adopt the hypotheſis of Mr Boſcovich, who ſuppoſes that matter is not impenetrable, as has, perhaps, been univerſally taken for granted; but that it conſiſts of phyſical points only, endued with powers of attraction and repulſion, in the ſame manner as ſolid matter is generally ſuppoſed to be: provided, therefore, that any body move with a ſufficient degree of velocity, or have a ſufficient momentum to overcome any powers of repulſion that it may meet with, it will find no difficulty in making its way through any body whatever; for nothing elſe will penetrate one another but powers ſuch as we know do in fact exiſt in the ſame place, and counterbalance or overrule one another. The moſt obvious difficulty, and indeed almoſt the only one, that attends this hypotheſis, as it ſuppoſes the mutual penetrability of matter, ariſes from the idea of the nature of matter, and the difficulty we meet with in attempting to force two bodies into the ſame place. But it is demonſtrable, that the firſt obſtruction ariſes from no actual contact of matter, but from mere powers of repulſion. This difficulty we can overcome, and having got within one ſphere of repulſion, we fancy that we are now impeded by the ſolid matter itſelf. But the very ſame is the opinion of the generality of mankind, with reſpect to the firſt obſtruction. Why, therefore, may not the next be only another ſphere of repulſion, which may only require a greater force than we can apply to overcome it, without diſordering the arrangement of the conſtituent particles, but which may be overcome by a body moving with the amazing velocity of light †."

73
Explained.

According to the theory of Boſcovich, the firſt elements or atoms of matter, are indiviſible, unextended, but ſimple, homogeneous, and finite in number. They are diſperſed in one immenſe ſpace, in ſuch a manner, that any two or more may be diſtant from each other any aſſignable interval. This interval may be indefinitely augmented or diminiſhed, but cannot entirely vaniſh. Actual contact of the atoms is therefore impoſſible, ſeeing that the repulſive power which prevents the entire vaniſhing of the interval muſt be ſufficient to deſtroy the greateſt velocities by which the atoms tend to unite. The repulſive power muſt encircle every atom, muſt be equal at equal diſtances from the atoms, and, moreover, muſt increaſe as the diſtance from the atoms diminiſhes. On the contrary, if the diſtance from the atoms increaſes, the repulſive power will diminiſh, and at laſt will become equal to nothing or vaniſh; then, and not till then, an attractive power commences, increaſes, diminiſhes, vaniſhes. But the theory does not ſtop here; for it ſuppoſes, that a repulſive power ſucceeds to the ſecond or attractive, increaſes, diminiſhes, vaniſhes; and that there are ſeveral alternations of this kind, till at the laſt an attractive power prevails; and though diminiſhing ſenſibly, as the ſquares of the diſtances increaſe, extends to the moſt diſtant regions of our ſyſtem. All the varieties of coheſion, Boſcovich has ſhown, may be ſatisfactorily accounted for from the diverſity of ſize, figure, and denſity of the cohering particles.

74
Matter in three ſtates.

Bodies exiſt in three different ſtates, which are quite diſtinct from each other; in the ſolid ſtate, the liquid, and in the ſtate of elaſtic fluid. Solidity, he ſuppoſes, is the conſequence of the irregular figure of the particles, and their great deviation from the ſpherical form, by which free motion among them is prevented. And thus, in ſolid bodies, the motion of one particle is followed by that of the whole maſs; or if the motion of the whole maſs requires a greater force to effect it than what is neceſſary to deſtroy the coheſion of the particles, the latter takes place. The diverſity in ſolids ariſes from the various degrees of force in the limits of coheſion.

75
Solid.

76
Fluid.

The particles of fluid bodies, according to Boſcovich, are ſpherical, and their forces are more directed to their centres than to their ſurfaces; by which motion is freely allowed when any force is applied. Fluids, he ſuppoſes, are of three kinds: one in which the particles have no mutual power, as ſand and fine powders: one in which they have repulſive power; ſuch are the elaſtic fluids, as air: and the third in which they have an attractive power, as water, mercury, &c. And theſe three kinds are produced by the primary differences in the particles which compoſe them.

77
Of three kinds.

78
Viſcid ſubſtances.

There is a claſs of bodies which are intermediate between the ſolids and fluids; the nature of which may be explained on the ſame principles. Theſe are the viſcid ſubſtances, the particles of which attract each other more ſtrongly than the fluids, but not ſo ſtrongly as the ſolids. In theſe bodies the particles deviate ſo far from the ſpherical form, as to produce a certain reſiſtance among each other, and to impede their relative motion.

79
Solution.

According to this theory, chemical phenomena may be traced to the ſame principle, namely the law of the forces and the differences in the particles which thence ariſe. Solution, for inſtance, is thus explained. The particles of ſome ſolid bodies have a leſs attraction for each other than for the particles of ſome fluids, and conſequently when theſe are applied to each other, the particles of the ſolid ſeparate, and combine with thoſe of the fluid; and thus a mixture of the two is formed. But the ſeparation of the particles of the ſolid can only take place ſo long as the particles of the fluid are in the ſphere of their attraction; and when either of them get beyond it, or when the attraction of the mixture thus formed becomes equal to the attraction of the particles of the ſolid for each other, no farther ſolution takes place, and the fluid is ſaid to be ſaturated. But if, into this mixture, another ſolid, whoſe particles have a greater attraction for the fluid, be introduced, the fluid will leave the former ſolid and combine with the particles of the latter. The particles of the former will fall to the bottom, or what is called *precipitation* takes place.

80
Evaporation.

Subſtances which are diſſolved, may not only be obtained again by precipitation, but alſo by ſlowly abſtracting part of the fluid in which they are diſſolved. This is called *evaporation*, and the ſolid bodies which are thus ſlowly formed, generally aſſume ſome regular ſhape, and are denominated *cryſtals*. As the fluid is removed, the particles come gradually into the ſphere of the attractive power of each other, and thus attain to ſome limit of coheſion, when the fluid which kept

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* *Math. Dict.* 287.

† *Hiſt of Viſion*, vol. i. p. 392.

them aſunder is removed. But when a ſolid is obtained by precipitation, the fluid is ſuddenly removed from betwixt the particles, which are conſequently left beyond the ſphere of attraction of each other, and do not therefore aſſume any regular form. And thus it will follow, that the more ſlowly the proceſs of evaporation goes on, the more regular will be the cryſtals which are formed; and this correſponds with experiment and obſervation*.

81 Cryſtallization.

Thus, ſolid bodies are found, either in irregular maſſes, or aſſume regular forms by cryſtallization; and the ſame ſubſtances which are capable of aſſuming regular figures, uniformly affect the ſame form; ſubject, however, to certain variations from particular circumſtances. No bodies can aſſume the form of cryſtals, excepting ſuch as can be reduced to the fluid ſtate. This, as is well known, is the uſual method of cryſtallizing ſalts. The ſubſtances to be cryſtallized are diſſolved in water, which is then ſlowly evaporated; and as the bulk of the fluid is diminiſhed, the particles gradually come nearer to each other, combine together, and form cryſtals. Theſe cryſtals, which are at firſt ſmall, receiving the addition of other particles, become larger, and fall to the bottom by their gravity.

Some ſaline bodies which are very ſoluble in hot water, are diſſolved but in ſmall proportion in cold water. Hot water, which is ſaturated with any of theſe ſalts, is no longer capable of holding them in ſolution when it cools. The particles then gradually approach each other, and arrange themſelves according to certain determinate forms, or in other words, they cryſtallize. Many of the ſaline bodies which cryſtallize in this manner, when they aſſume the ſolid form, combine with a conſiderable portion of water, which is called the *water of cryſtallization*. But on the other hand, there is another claſs of ſaline bodies which aſſume regular forms according to a different law. Being equally ſoluble in hot and in cold water, they cannot be cryſtallized by cooling the fluid in which they are diſſolved, but by diminiſhing its quantity; and this is effected by continuing the application of heat; that is, by the proceſs of evaporation. Salts which are cryſtallized in theſe circumſtances, contain but a ſmall quantity of water of cryſtallization. This is the caſe with common ſalt, which is cryſtallized by boiling the fluid which holds it in ſolution.

Many ſubſtances aſſume regular forms which are not ſoluble in any liquid. Such, for inſtance, is the caſe with metallic ſubſtances, and with glaſs, as well as ſome other bodies. To cryſtallize ſubſtances of this nature, they muſt be ſubjected to fuſion, and thus by combining with caloric, they are reduced to the liquid ſtate, and the particles being ſeparated from each other, are left at liberty to arrange themſelves into regular forms, or to cryſtallize, and by ſlow and gradual cooling, the cryſtals are obtained more perfect.

82 Accounted for by

But what is the cauſe that the particles of bodies, in theſe circumſtances, arrange themſelves in this manner? or what is the cauſe of the ſame bodies in the ſame circumſtances aſſuming regular figures? According to ſome of the ancient philoſophers, the elements of bodies conſiſted of certain regular geometrical figures; but it does not appear that they employed this theory to explain cryſtallization. The regular figure of cryſtals was aſcribed by the ſchoolmen to their ſubſtantial forms; while others ſuppoſed that it was owing merely to the aggregation of the particles, without, however, explaining the reaſon of this aggregation, or of the regular figures which it formed.

83 Newton,

According to Newton, and the theory of Boſcovich which we have quoted, the particles of bodies which are held in ſolution by a fluid, are arranged in regular order, and at regular diſtances. When the force of coheſion between the particles and the fluid is diminiſhed, it is increaſed between the particles themſelves; they therefore ſeparate from the fluid, and combine together in groups, which are compoſed of the particles neareſt to each other. If it be ſuppoſed, that the particles which compoſe the ſame body have the ſame figure, the aggregation of any determinate number of ſuch particles will produce ſimilar figures. According to the ingenious theory of the Abbé Hauy, the integrant particles always combine in the ſame body in the ſame way; they attach themſelves together by the ſame faces or the ſame edges; but theſe faces and edges are different in different cryſtals. And although the ſame ſubſtances are obſerved to cryſtallize in a great variety of different forms, yet they all contain what Hauy calls the *primitive* form, or have it within them as a nucleus; and this nucleus or primitive figure may be extracted by careful mechanical diviſion. If then the figure of cryſtals is owing to the figure of the integrant particles, and to the peculiar mode of their arrangement in combination, theſe particles, when they are left at full liberty, as is the caſe when they are diſſolved in a fluid, will combine in the ſame way, and thus the cryſtals of the ſame body will always exhibit ſimilar forms.

84 by Hauy,

85 who aſcribes it to

86 the primitive forms.

In proſecuting this ſubject, Hauy found that all the primitive forms of cryſtals which he had obſerved, might be reduced to ſix; namely,

1. The parallelopiped.
2. The tetrahedron.
3. The octahedron.
4. The regular ſix-ſided priſm.
5. The dodecahedron, terminated by equal rhombs.
6. The dodecahedron, with triangular faces, compoſed of two pyramids, united baſe to baſe.

But the nucleus or primitive form of a cryſtal, he obſerves, is not the laſt term of its mechanical diviſion. It may be ſubdivided parallel to its different faces, and ſometimes alſo in different directions. If the nucleus or primitive form be a parallelopiped which cannot be ſubdivided, but in a direction parallel to its faces, as takes place in carbonate of lime, it is obvious that the integrant particle or molecule is ſimilar to the nucleus itſelf. And he has found by experiment, that the figure of the integrant particles of all cryſtals may be reduced to the three following. Theſe are.

87 Figure of the integrant particles.

1. The tetrahedron, or the ſimpleſt of all pyramids.
2. The triangular priſm, or the ſimpleſt of all the priſms.
3. The parallelopiped, or the ſimpleſt of the ſolids, which have their faces parallel.

From theſe primitive forms, the difference of ſize, proportion, and denſity of the different particles of bodies, he ſuppoſes, may account for all the differences of attraction which take place in ſimple aggregation and compoſition of bodies. The integrant particles ſometimes unite by their faces, and ſometimes by their edges, in forming the primitive cryſtals; and this accounts for the different figures of the primitive cryſtals, which are compoſed of integrant particles of the ſame form. But bodies when they are cryſtallized, do not always exhibit the ſame primitive form. The deviations from this, and the varieties of

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* See *Boſcovich's theory*.

88 Secondary forms

forms which are produced, are called by Hauy *ſecondary forms*. In ſome ſalts, for inſtance, the primitive form is the octahedron; but in deviating from this form, they aſſume, when cryſtallized, that of the cube or the dodecahedron.

Theſe ſecondary forms ſeem to depend ſometimes on variations in the ingredients which compoſe the integrant particles of particular bodies, the ſolvent in which the cryſtals are formed, or the different decrements of the laminæ of the cryſtals. But for a full view of this ingenious theory, ſee CRYSTALLIZATION.

SECT. III. *Of the Attraction of* COMPOSITION.

Bodies which are compoſed of particles of the ſame nature cohere with a certain force, as in the particles of water or of mercury, and thoſe of wood or of metal; and this force, we have ſeen, acts with very different degrees of intenſity. In the two former, the water and the mercury, it is comparatively weak, but in the two latter it is very powerful.

89 explained.

But the diſſimilar particles of bodies alſo enter into combination; and thus combined, form homogeneous ſubſtances, whoſe particles cohere with very great force; and wherever theſe combinations take place, the force of coheſion between the particles of each of the bodies muſt be deſtroyed or overcome, before the new combination can take place. Thus a piece of marble is diſſolved in muriatic acid; but before this can take place, the force of coheſion which exiſted between the particles of the marble muſt be overcome; or, in other words, the force of attraction between the particles of muriatic acid and the particles of the marble is greater than that between the particles of marble themſelves. This attraction then which exiſts between the particles of ſubſtances of a different nature, has been called the *attraction of compoſition*, *heterogeneous affinity*, or more properly *chemical affinity*.

90 This affinity limited.

This attraction, or this affinity, does not exiſt between the particles of all bodies. Thus there is no affinity between a piece of marble and water, as is the caſe between marble and muriatic acid; and it is ſaid that there is no affinity between oil and water, becauſe the particles of the one do not enter into combination with thoſe of the other.

91 Importance of it.

Chemiſtry may be ſaid to be the hiſtory of affinities, as it conſiſts in the detail of the numerous and various compoſitions and decompoſitions which take place among natural bodies. Without attending to the phenomena which ariſe from affinity, the chemiſt could carry on no proceſs, either of ſyntheſis or analyſis; for it is by means of their affinities that the chemical nature of bodies can be diſcovered.

In taking a general view of the phenomena which depend upon chemical attraction, the changes or events which are the reſults of this action, have been divided into certain claſſes, and from their being conſtant and uniform, they have been characterized by the name of *laws of chemical affinity*. Theſe may be conſidered as chemical axioms which are the principles or foundation of the ſcience, and therefore it is neceſſary that they ſhould be well underſtood, before we enter into the detail of the facts which it embraces.

92 Laws.

The celebrated Fourcroy, whoſe indefatigable labours and extenſive views in chemical ſcience will always be admired and valued, has arranged the facts which depend on chemical affinity under ten different heads, which he has denominated *the laws of affinity*. In illuſtrating this intereſting part of chemical ſcience, we ſhall obſerve the ſame arrangement.

FIRST LAW.

93 Affinity between diſſimilar particles.

Chemical affinity takes place only between bodies of a different nature, or between diſſimilar particles.

This law, when conſidered as a law of chemical affinity, may be regarded as negative; for when the particles of bodies of the ſame nature combine together, it is by the force of coheſion, and therefore comes under that ſpecies of affinity called the attraction of aggregation. No chemical action has taken place, no new compound is formed; which are the characteriſtics of chemical affinity.

But as an inſtance of the effect of chemical affinity between two bodies of a different nature, we may refer to the experiment above alluded to, of the combination which takes place between a piece of marble and muriatic acid; for by the mutual action between theſe two bodies the marble has diſappeared, and the acid has totally changed its properties. The compound, which is the reſult of this combination, proves that the heterogeneous bodies have entered into intimate union with each other.

Chemical affinity may act between two bodies, and a combination take place, when theſe bodies are totally uncombined with all others. In this caſe the combination is produced by the force of affinity between the two bodies; but when one or both of theſe bodies is in a ſtate of combination with others, the bodies which are ſaid to have the greater affinity for each other, do not entirely combine together, and leave the bodies with which they were firſt in combination. Suppoſe A and B are two bodies which have an affinity for each other, and are in a ſtate of combination; and ſuppoſe C is a third body which has a ſtronger affinity for the body B than the affinity which exiſts between A and B. Now, the body C having a greater affinity for the body B than what exiſts between the compound body AB when it is brought into circumſtances where the force of that affinity can be exerted, the compound body AB will be decompoſed, that is, the body C will combine with the body B, and will leave the body A. It was formerly ſuppoſed by chemical philoſophers, that this decompoſition was complete; that is, as in the caſe ſtated above, the affinity between C and B being greater than the affinity between A and B, the body C, when in ſufficient quantity, abſtracted every particle of the body B from its combination with the body A. But the experiments and obſervations of the ſagacious Berthollet have placed this matter in a new light. This will be beſt illuſtrated by detailing ſome of the experiments by which this ingenious philoſopher has clearly aſcertained many curious facts with regard to chemical affinity (D).

94 Examples.

The ſulphuric acid has a very ſtrong affinity for the earth called barytes, forming with it a compound which is inſoluble either in hot or cold water. Sulphuric acid alſo has an affinity for potaſh, but it is much weaker than that which exiſts between the acid and barytes; yet the potaſh, although poſſeſſed of the weaker affinity, abſtracts part of the ſulphuric acid from the barytes, and combines with it. This is proved by Berthollet in the following experiment.

1. He took equal quantities of pure potaſh, and ſulphate of barytes (E), and boiled them together in a ſmall quantity of water. According to the views of former chemiſts with regard to chemical affinity, no decompoſition ſhould take place, becauſe the affinity between the ſulphuric acid and the barytes was ſtronger than that between the acid and the potaſh. But from the reſult of this experiment it appears, that the ſulphate of barytes was partially decompoſed by the potaſh, and that the ſulphuric acid was divided between the two baſes; that is, between the barytes and the potaſh.

2. The oxalic acid has a greater affinity for lime than for potaſh; but if oxalate of lime, that is oxalic acid combined with lime, be boiled along with potaſh in a ſmall quantity of water in the proportion of one part of the oxalate of lime to two of the potaſh, a partial decompoſition of the oxalate of lime will take place, part of the oxalic acid is abſtracted from the lime, and combines with the potaſh *.

* *Reſearches, Tranſ.*

95 Affinity increaſed by the maſs.

3. One part of phoſphate of lime was boiled together in a ſmall quantity of water with two parts of potaſh. The phoſphoric acid has a greater affinity for lime than for potaſh; but from this experiment it appeared that the phoſphate of lime was partially decompoſed, and part of the phoſphoric acid having combined with the potaſh, formed the new compound, phoſphate of potaſh.

From theſe experiments Berthollet obſerves, that the baſes which are ſuppoſed to form the ſtrongeſt combinations with the acids may be ſeparated from them by others whoſe affinities are ſuppoſed to be weaker, and that the acid divides itſelf between the two baſes. Where a ſmall quantity only of the decompoſing ſubſtance is employed, the effect is not perceptible; but if a large quantity be employed, as in one of the above experiments, if the ſulphate of barytes had been treated with ſucceſſive portions of potaſh, it would have been ultimately and almoſt entirely decompoſed; for the weaker affinity of any body is made up by increaſing the quantity of that body.

Bergman has remarked, that if ſix times as much of the decompoſing ſubſtance be employed as is ſufficient to ſaturate the baſe, a decompoſition will be effected which may be conſidered as total, becauſe the oppoſing ſubſtance retains ſo ſmall a part of that with which it was combined, that it may eſcape the obſerver's notice, and be conſidered as an evaneſcent quantity. But the above experiments ſhew, that a ſimilar decompoſition could be produced, if the reverſe of the experiment which Bergman recommends had been attempted.

When one ſubſtance acts on another in combination with a third, the ſubject of combination divides itſelf between the two others, not only in proportion to the energy of their reſpective affinities, but alſo in proportion to their quantities. The two ſubſtances which act on the combination may be conſidered as oppoſing forces acting on the ſubject of combination, and ſharing it between them in proportion to the intenſity of their action; and this intenſity may be eſtimated by the quantity of the ſubſtance and the energy of its affinity. The effect, therefore, muſt increaſe or diminiſh as the quantity increaſes or diminiſhes. Thus it appears that elective affinity in general does not act as a determinate force by which one body can completely ſeparate another from a combination; but that in all compoſitions and decompoſitions produced by affinity, there is a partition of the ſubject of the combination between the two bodies, the energy of whoſe affinities is oppoſed, and the proportions of this partition depend not ſolely on the difference of energy in the affinities, but alſo on the difference of the quantities of the bodies; for it has been obſerved that an exceſs of the quantity of the body whoſe affinity is the weaker, compenſates for the weakneſs of affinity.

SECOND LAW.

96 Affinity between the ultimate particles.

Chemical affinity takes place only between the ultimate particles of bodies.

The attraction of aggregation or coheſion which is exerted between the integrant particles of bodies, is oppoſed to the action of chemical affinity. For, as in the caſe juſt mentioned, of the combination that takes place between a piece of marble and muriatic acid, the force of coheſion between the particles of the marble muſt be overcome before chemical action begins, and a new compound can be formed. The new compound conſiſts of the conſtituent particles of the two bodies, which are now intimately united by the force of affinity which exiſts between them.

THIRD LAW.

97 Between ſeveral bodies.

Chemical affinity takes place between ſeveral bodies.

It is not merely compounds conſiſting of the particles of two bodies, that are formed by chemical affinity, for we ſhall find that there are numerous inſtances of three or four ſubſtances entering into chemical combination. Alum, a well-known ſubſtance, is a compound of three ſubſtances which have entered into chemical union. Theſe are, ſulphuric acid, alumina or pure clay, and potaſh. The ſame thing happens alſo in all thoſe compounds which are called triple ſalts, which conſiſt, like alum, of three different ſubſtances; but

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(D) The reader, it is hoped, will find no difficulty in underſtanding the general reaſonings on this ſubject; but he will be able to comprehend it fully, after the ſubſtances whoſe affinities are given as examples, are treated of in detail in their proper places.

(E) This is the compound of ſulphuric acid and barytes, according to the new chemical nomenclature, the principles of which will be afterwards explained.

98 Alloy of metals.

but the moſt remarkable inſtances of the effects of chemical affinity on ſeveral bodies are obſerved in the alloys of ſome of the metals. The temperature at which the metals are fuſed is generally pretty high, but an alloy of ſome of them may be brought to a ſtate of fuſion at a low temperature. This is the caſe with the alloy of biſmuth, lead, and tin, which may be melted at the temperature of boiling water, which is far below the fuſing point of any of the uncombined metals, and ſhews by this change of their properties, that a chemical union has been effected.

FOURTH LAW.

99 One body muſt be fluid.

That chemical affinity may take place between two bodies, it is neceſſary that one of them be in the liquid or fluid ſtate.

The ſolution of a ſolid body in a fluid, may be conſidered as the deſtruction of the coheſion of its particles, and their equal diffuſion in that fluid. It is the combination of the particles of the ſolid with thoſe of the fluid; and the compound ſtill poſſeſſes the characteriſtic phyſical properties of the fluid. Thus, in the firſt place, the force of coheſion between the particles of a ſolid body is deſtroyed, by its ſolution in a fluid; which force muſt always be overcome before a new compound can be formed by the action of chemical affinity. But, 2dly, The particles of a body diſſolved in a fluid are in their ultimate, or at leaſt very minute, ſtate of diviſion; by which means the points of contact between the particles of the body held in ſolution, and thoſe of any other with which it may combine, are greatly multiplied; and thus the operation of chemical action between theſe particles is greatly extended. Many familiar proceſſes are examples of the effects of ſolution, as ſugar diſſolved in water; common ſalt in the ſame fluid; or the experiment mentioned above, of marble in muriatic acid. In the proceſs of making glaſs we have another example of the ſame nature. The two ſubſtances which enter into the compoſition of glaſs are in the ſolid ſtate. Theſe are ſiliceous earth or ſand, and an alkali. But to effect the combination of the two ſolids, one of them is brought to the fluid ſtate by the application of heat. The alkali firſt melts, and in the ſtate of fuſion the ſand or ſiliceous earth combines with it, and forms an uniform compound, which is glaſs.

100 Effect of ſolubility.

But Berthollet has ſhewn, that the ſolubility of bodies has a very great influence in modifying the action of chemical affinity. For, he obſerves, when a body is in ſome degree ſoluble, its action is compoſed of that of the part diſſolved and of that of the part which has retained its ſolidity. It follows that its action does not increaſe in proportion to the quantity employed. Lime, for inſtance, acts by the part diſſolved, and by that which remains ſolid; but it is probably the diſſolved part which contributes principally to the effect produced. If the quantity of lime employed in an experiment be doubled, without increaſing the quantity of the liquid, the quantity of lime diſſolved will rather be diminiſhed than increaſed, becauſe a part of the liquid is abſorbed by the lime which has been added.

If an inſoluble combination can become ſoluble by being deprived of a part of its compoſition, the inconvenience of inſolubility is eaſily removed. Thus it is when the phoſphate of lime is acted on by an acid. The part of it which is within the ſphere of action is inſtantly converted into an acidulous phoſphate, and the other part ſucceſſively, until both the oppoſed ſubſtances be reduced to a liquid ſtate.

" When an eliminated ſubſtance becomes inſoluble, the precipitate which is formed retains a portion of the ſubſtance with which it was combined, in proportion to the individual forces which acted in the moment of the precipitation. The operation is no farther influenced by this portion, ſo that the quantity of the precipitating body adequate to the precipitation is all that is neceſſary until the end of the operation. But the caſe is different when the eliminated ſubſtance aſſumes the liquid ſtate, for then the reſiſtance increaſes according to the progreſs of the decompoſition; and hence it follows, if a ſubſtance nearly inſoluble be oppoſed to a combination, and its action be conſequently only partial, whilſt the ſubſtance eliminated remains liquid, that the decompoſition muſt be quickly ſtopped, whatever may be the force of the affinities. Becauſe it has been already ſhewn that the decompoſing action depends not merely on the affinities, but alſo on the relative quantities in action. When the ſulphate of potaſh was decompoſed by means of lime, the operation was neceſſarily ſtopped as ſoon as the ſulphuric acid was entirely divided between the potaſh and lime, in proportion to their reſpective affinities, and to the quantity of each which had acted on the ſulphuric acid; that is, in proportion to their reſpective maſſes *."

101 Elaſtic fluids.

But fluids in the elaſtic ſtate, or the ſtate of gas, produce effects which are contrary to thoſe of the force of coheſion; and thus modify in a different manner the effects of the particular affinity of each ſubſtance. Elaſticity acts, either by the removal of ſome ſubſtances from the action of others, or by diminiſhing their proportion within the ſphere of action. But if all the ſubſtances in action be in the elaſtic ſtate, this effect will not follow, becauſe then they all exiſt in a ſimilar condition. When a ſubſtance, on ſeparating from an intimate combination, aſſumes the ſtate of gas, it becomes elaſtic, and then it can oppoſe no further reſiſtance to the decompoſing action. And thus it appears that ſubſtances of this nature do not act by their maſs. A complete decompoſition can then be effected by the decompoſing ſubſtance, and no greater quantity of it is required than what would have been neceſſary to form the compound by direct combination. Thus, carbonic acid, which is an elaſtic fluid, may be diſengaged from its combination by another ſubſtance whoſe affinity for the baſe may be leſs, becauſe that other ſubſtance can act by its maſs, and can therefore overcome the affinity of the carbonic acid by its ſucceſſive action. But if the whole of the carbonic acid is to be expelled, the decompoſing ſubſtance muſt be uſed in greater quantity than what is juſt neceſſary to produce ſaturation.

102 Example.

The action which takes place when concentrated ſulphuric acid is poured on dry common ſalt, that is, both ſubſtances being as much as poſſible deprived of water, affords a good illuſtration of the effect of the elaſticity of one of the ſubſtances. Common ſalt is compoſed of muriatic acid and ſoda. The affinity of the ſulphuric acid for ſoda is greater than that of muriatic acid. When, therefore, the ſulphuric acid is poured on the common ſalt, it combines with the ſoda, and the affinity of the muriatic acid is diminiſhed. It conſequently aſſumes the gaſeous ſtate, and acts no longer by its maſs. But if a ſolution of common ſalt in water be employed, or a diluted acid, then the muriatic acid may be retained in the water, and in this caſe it can act by its maſs.

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* Berthollet's Reſearches.

When, therefore, a ſubſtance is in the ſtate of gas, its elaſticity is to be conſidered as a force oppoſed to the affinity of liquid ſubſtances. When the elaſticity of gaſeous ſubſtances is diminiſhed, as happens by compreſſion, they then combine in greater quantity with liquids. When water is brought into contact with carbonic acid, which is in the ſtate of gas, it does not become ſaturated with that acid, becauſe the elaſticity of the gaſeous acid oppoſes the diſſolving power of the water: and before its diſſolving force is exhauſted, the two forces are balanced. But when the oppoſing elaſtic force is diminiſhed, as by compreſſion, the diſſolving power of the water continues its action, and thus it is more fully ſaturated with the acid.

FIFTH LAW.

103 Change of temperature.

When bodies combine together, they undergo a change of temperature.

In all bodies there exiſts a certain quantity of caloric, or the matter of heat; but when any change takes place in the nature or conſtitution of any body, its power of retaining that portion of caloric is alſo changed. During theſe changes heat is either given out or abſorbed; and this increaſe or diminution of temperature becomes obvious to our ſenſes, or may be meaſured by the thermometer.

The effects of this variation of temperature will be greater or leſs, in promoting or retarding the action of chemical affinity, according to the change which takes place on the ſubſtances which are decompoſed, or according to the ſtate of the compound which is formed. When there is a great elevation of temperature, in conſequence of the heat produced by the combination of ſubſtances, it is neceſſary to attend to the difference of volatility of which the ſubſtances are ſuſceptible by that elevation of temperature. If the ſubſtances are not all in the liquid ſtate, or if one of them only be ſoluble, the effect of heat is to favour their mutual action; becauſe the force of coheſion, which acts even between the particles of bodies in the liquid ſtate, is thus diminiſhed. If the expanſion by heat of the one of two ſubſtances be greater than that of the other, the more expanded ſubſtance acquires a greater degree of elaſticity, and this, as has been already obſerved, muſt be conſidered as a force oppoſing the affinity which exiſted between the two bodies.

In chemical combinations, according to this law, the temperature changes; and it is either increaſed or diminiſhed, according to the nature of the combination which is effected. This will be beſt illuſtrated by an example or two.

104 Examples.

1. When lime is ſlaked, that is, when water is thrown upon burnt lime, a great elevation of temperature takes place. The water enters into combination with the lime; it paſſes from the fluid to the ſolid ſtate; and, during this change, a great quantity of caloric, or the matter of heat, is given out, which is the cauſe of the increaſe of temperature (F).

2. As an example of two fluids when mixed together producing a ſimilar effect, take four parts of concentrated ſulphuric acid, and pour it on one part of water; the temperature of the combined fluids will be elevated to the boiling point of water.

In the ſolution of ſolid bodies in a fluid, there is a great change of temperature; but in this caſe it is diminiſhed. This is particularly the caſe when ſalts are diſſolved in water.

1. Take muriate of ammonia, or ſal ammoniac, and diſſolve it in water, and while the ſolution is going on, if a thermometer be plunged into it, there will be a conſiderable fall of the mercury in conſequence of the abſorption of caloric, or the diminution of temperature.

2. If one part of water, at the temperature of 50° or 60° of Fahrenheit, be poured on an equal quantity of ice, the temperature of the water will be diminiſhed to the freezing point, or 32°.

3. A very low temperature is produced by a mixture of ice and common ſalt; and a ſtill lower by a mixture of ſnow and powdered muriate of lime. But we ſhall become better acquainted with the effects of theſe ſubſtances in explaining the method of producing artificial cold.

SIXTH LAW.

105 Compounds have new properties.

The compounds formed by chemical affinity poſſeſs new properties, and different from thoſe of their conſtituent parts.

We are too little acquainted with the nature of chemical affinity, to be able to determine, *à priori*, what is to be the reſult of a combination between two ſubſtances. No information can be obtained what the nature of the union will be, from knowing the properties of the ſubſtances which are to be combined. It is only by experiment that the nature and properties of the new compound can be aſcertained.

Unwilling to ſuppoſe, or unable to conceive, that the properties of the two ſubſtances which enter into combination, had totally diſappeared in the new compound, the earlier chemiſts imagined that the properties of the latter were of a middle nature, conſiſting of the mixed properties of the compoſing ſubſtances. Hence the compounds of the acids and the alkalies were denominated *middle ſalts*, *ſales medii*, from poſſeſſing the combined properties of their component ſubſtances.

But the truth of this doctrine, with regard to the nature of compound ſubſtances, has been fully diſproved by the more accurate obſervations of modern chemiſts; for it is found by experiment that the compound formed exhibits not a ſingle property of any of the ſubſtances of which it is compoſed. On the contrary, of two mild and inſipid ſubſtances, a compound is formed which is highly acrid and corroſive;

(F) The explanation of this phenomenon will be given, when we come to treat of heat.

ſive; and the reſult of the combination of two powerfully corroſive ſubſtances, is frequently a mild and inſipid compound.

It is indeed one of the characteriſtics of chemical affinity, that there be a total change in the properties of the ſubſtances which enter into combination. This change takes place in the ſenſible qualities of many of the compounds, and ſome of theſe, as an illuſtration of this law, may be mentioned.

(1.) Changes of colour. The colour of lead is a bluiſh white, but when it combines with oxygen it aſſumes a bright yellow or red colour, in proportion to the quantity of oxygen. Cobalt, which is of a gray colour, when combined with oxygen becomes of a fine blue; and copper, which is red, combined in the ſame way, exhibits a green colour.

(2.) Changes in ſmell. 1. The ſmell of muriatic acid is highly pungent; ammonia, or the volatile alkali, is not leſs ſo; but when theſe two are combined, forming muriate of ammonia, or ſal ammoniac, the new compound is perfectly inodorous. This laſt is a remarkable inſtance of two highly volatile and odorous ſubſtances becoming fixed in the compound, and deſtitute of ſmell, and thus exhibiting a total change of their properties.

2. The ſmell of ſulphur and of potaſh is ſcarcely perceptible in the uncombined ſtate; but when they are united together, and moiſtened with water, a moſt fetid and offenſive odour is emitted.

(3.) Changes in taſte. 1. The taſte of ſulphur is nearly inſipid; and oxygen, which is one of the component parts of the atmoſphere, is not only innocent, but neceſſary for the exiſtence of animals: but when theſe two enter into union, the compound formed, which is ſulphuric acid, is one of the moſt corroſive ſubſtances.

2. Sulphuric acid, which is ſour and corroſive, forms a combination with ſoda, which is alſo of a corroſive nature; the reſult, which is Glauber ſalt, or ſulphate of ſoda, is a compound of a bitter nauſeous taſte, but poſſeſſing none of the properties of its component parts.

SEVENTH LAW.

106 Force of affinity

The force of chemical affinity, is eſtimated by the force which is neceſſary to ſeparate the ſubſtances which enter into combination.

In treating of coheſion, or the attraction of aggregation, it was ſtated, that the method employed by philoſophers to eſtimate that force, was to meaſure the oppoſite force, or that which was neceſſary to overcome the coheſive force. Thus, the weight attached to the lower extremity of a metallic wire perpendicularly ſuſpended, which was juſt ſufficient to tear it aſunder, is conſidered as the meaſure of its power of coheſion. But it will appear from what follows that this law muſt be adopted with conſiderable modification.

107 eſtimated by the time of ſolution;

In eſtimating the force of chemical affinity, various methods have been propoſed by different philoſophical chemiſts. It was thought by Wenzel, that the time which one body required to diſſolve another, might be conſidered as the meaſure of the force of affinity between theſe two bodies; but it muſt appear from what has been already ſaid, that the time of ſolution muſt depend greatly on the coheſive force of the body which is to be diſſolved, and the nature of the compound which is formed; ſo that from theſe deviations, no certain meaſure can be obtained from this method.

108 by the difficulty of ſeparation

According to ſome, the meaſure of the force of chemical affinity may be eſtimated by the difficulty of ſeparating the ſubſtances which have entered into combination; or, by taking the compound ratio of the facility with which they are combined. But as no method has been invented to aſcertain either the one or the other, which are the neceſſary previous ſteps in the method propoſed, it is impoſſible, in this way, to eſtimate the force of chemical affinities.

109 by the affinity for caloric.

Obſerving the effects of the union and abſtraction of caloric, in the operations of chemical affinity, Lavoiſier and La Place, in a memoir publiſhed in 1783, propoſed this as the method of eſtimating the force of affinity. But it ſeems ſcarcely poſſible to meaſure the force of chemical affinity between two ſubſtances by the degree of temperature which is required to overcome the force of coheſion; or, as this degree of temperature has no meaſurable proportion with the force of chemical affinity, it can afford no data for eſtimating this force. And this quantity being variable and unknown, a fixed term is wanting to form a ſcale of compariſon.

We have already mentioned, in treating of adheſion, the experiments of Dr Taylor on the adheſion of ſurfaces, and the experiments and concluſions of Morveau and Achard on the ſame ſubject. From theſe Morveau has propoſed to deduce a method of eſtimating the force of chemical affinities. But for an account of this, we refer the reader to the firſt ſection.

110 Kirwan's method.

A different method has been propoſed by Mr Kirwan, in his experiments and obſervations on the attractive powers of mineral acids *. He obſerves, that the principal end which he had "in view was, to aſcertain and meaſure the degrees of affinity or attraction that ſubſiſt between the mineral acids, and the various baſes with which they may be combined; a ſubject of the greateſt importance, as it is upon this foundation that chemiſtry, conſidered as a ſcience, muſt finally reſt; and though much has been already done, and many general obſervations laid down on this head, yet ſo many exceptions have occurred, even to ſuch of theſe obſervations as ſeem to have been moſt firmly eſtabliſhed, that not only a variety of tables of affinity have been formed, but many very eminent chemiſts have been induced to doubt whether any general law whatſoever could be traced" †.

"The diſcovery of the quantity of real acid in each of the mineral acid liquors, and the proportion of real acid taken up by a given quantity of each baſis at the point of ſaturation, led me unexpectedly to what ſeems to me the true method of inveſtigating the quantity of attraction which each acid bears to the ſeveral baſes to which it is capable of uniting. For it was impoſſible not to perceive,

1ſt, That the quantity of real acid neceſſary to ſaturate a given weight of each baſe, is inverſely as the affinity of each baſe to ſuch acid.

2dly, That the quantity of each baſe requiſite to ſaturate a given quantity of each acid, is directly as the affinity of each acid to ſuch baſe.

Thus, 100 grs. of each of the acids require for their ſaturation, a greater quantity of fixed alkali than of calcareous earths, more of this earth than of volatile alkali, more of this alkali than of magneſia, and more of magneſia, than of earth of alum; as may be ſeen in the following table.

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* *Phil. Tranſ.* vol. lxxiii.

† *Ibid.* p. 34.

Quantity of baſe taken up by 100 grs. of each of the three acids.

	Potaſh	Soda.	Lime.	Ammonia.	Magneſia.	Alum.
	grs.	grs.	grs.	grs	grs.	grs.
Sulphuric acid.	215	165	110	90	80	75
Nitric acid.	215	165	96	87	75	65
Muriatic acid.	215	158	89	79	71	55

"As theſe numbers," Mr Kirwan obſerves, "agree with what common experience teaches us concerning the affinity of theſe acids with their reſpective baſes, they may be conſidered as adequate expreſſions of the quantity of that affinity. Thus, the affinity of the ſulphuric acid to potaſh, that is, the force with which they unite to each other, is to the affinity with which the ſame acid unites to lime, as 215 grs. to 110; and to that which the nitric acid bears to lime, as 215 to 96."

111 Objections. But to this method of Mr Kirwan objections have been made by Morveau and Berthollet. It is ſtated that the eſſential principle of the force of affinity being in the direct ratio to the quantity of baſe, is not fully eſtabliſhed. According to the experiments of Morveau, a quantity of ſulphuric acid containing 100 grs. of real acid, required for ſaturation 201 grs. of cryſtallized carbonate of potaſh: a quantity of nitric acid which contained 100 grs. of real acid, required 302 grs. for ſaturation; and a quantity of muriatic acid containing 100 grs. of real acid, required no leſs than 905 grs. of the ſame ſalt for ſaturation. From theſe experiments it appears, that Mr Kirwan's calculations are erroneous, or that the principle on which he has proceeded is falſe; for equal quantities of real acids require for ſaturation different quantities of potaſh; and beſides, the quantity of baſe required is in the inverſe ratio to the force of affinity, which is the reverſe of Mr Kirwan's principle.

Mr Kirwan, however, has acknowledged the force of theſe objections, and has deduced the proportion of real acid in the nitric and ſulphuric acids, from leſs exceptionable principles. His table, therefore, which expreſſes in numbers the ſtrength of affinities, is conſidered as the moſt correct which has yet been publiſhed; and his general principle, that the quantity of baſe required to ſaturate a given quantity of real acid, is the expreſſion of the force of affinity between the acid and the baſe, ſeems to receive additional confirmation in proportion to the progreſs of chemical knowledge.

Mr Kirwan has corrected the quantity of baſe taken up by 100 parts of ſulphuric, nitric, muriatic, and carbonic acids, as will be ſeen in the following table *.

100 pts.	Potaſh.	Soda.	Ammonia.	Barytes.	Strontites.	Lime.	Magneſia.
Sulphuric.	121.48	78.32	26.05	200.	138.	70.	57.92
Nitric.	117.7	73.43	40.35	178.12	116.86	55.7	47.64
Muriatic.	177.6	136.2	58.48	314.46	216.21	118.3	89.8
Carbonic.	95.1	149.6		354.5	231.+	122.	50.

But according to the experiments and obſervations of Berthollet, as the force of affinity varies in proportion to the maſs of any body, no method, however accurate in other reſpects, will afford a certain rule for eſtimating the force of chemical affinity.

EIGHTH LAW.

112 Different affinities among bodies. *Bodies have different degrees of affinity for each other.* On the different force of affinity which exiſts between different bodies, depend many of the moſt important operations in chemiſtry; and it is by multiplying the objects of this law, that chemical ſcience can be improved and extended.

113 Two kinds. Affinities have been divided into two kinds, *ſimple* affinity, and *compound* affinity; or ſimple elective attractions, and double elective attractions.

114 Between two bodies. *Simple affinity.*—The firſt of theſe includes all thoſe combinations which directly take place between two bodies, as when muriatic acid and lime are combined together. It is alſo a caſe of ſimple affinity, or ſingle elective attraction, when to a ſolution which contains two ſubſtances, there is added a third which produces the ſeparation of one of the diſſolved bodies. This takes place when potaſh is added to the ſolution of lime in muriatic acid. The potaſh has a ſtronger affinity for the muriatic acid than the lime; it therefore ſeparates the acid from the lime, combines with it, and remains in the ſolution. The lime thus ſeparated from its combination, appears in the ſolid form, and falls to the bottom. This is called a precipitate.

115 Precipitates. In practical chemiſtry precipitates are diſtinguiſhed into ſeveral kinds. It is ſaid to be a real or true precipitate when the body which is diſengaged from the combination falls to the bottom, as in the caſe above where the lime fell to the bottom, after being ſeparated from the muriatic acid. A falſe precipitate is when the new compound which is formed falls down, as when ſulphuric acid is added to any ſolution of lime; for the compound being inſoluble, it appears in the form of a precipitate. A precipitate is ſaid to be pure when the body which has been decompoſed, can be formed again from the ſeparated conſtituent parts; and impure

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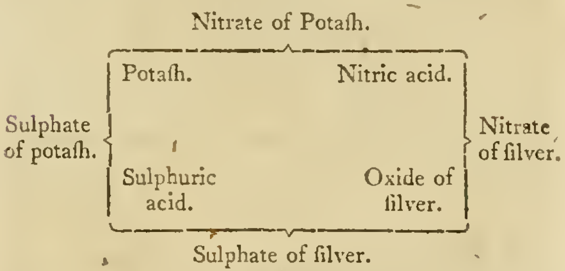
* *Anal of Min. Waters.*

when this cannot be effected; that is, probably, when the decompoſition has not been complete. It ſometimes happens when a body which conſiſts of two ſubſtances, is decompoſed by means of a third, that the diſengaged ſubſtance aſſumes the elaſtic form. This is the caſe when muriate of ammonia is decompoſed by quicklime. The muriatic acid which is in combination with the ammonia, unites with the lime, for which it has the greater attraction; and the ammonia is ſet free, and is inſtantly volatilized.

116
Between more than two.

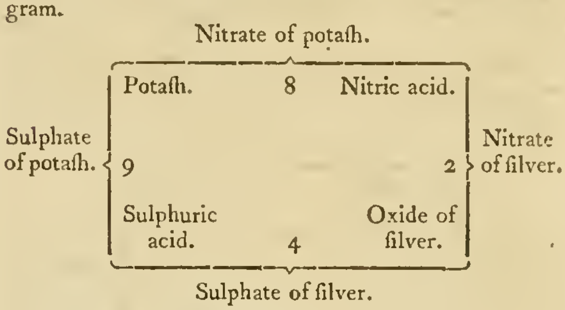
Compound affinity.—But there are ſubſtances which cannot be decompoſed when a third ſubſtance is preſented. The affinity of the two ſubſtances A and B in combination, may be ſo much ſtronger than the affinity of a third C for either A or B, that no decompoſition will take place when the body C is preſented to the compound of A and B. Suppoſe the two ſubſtances A and B are held united with a force equal to 12, and the force of affinity between the body C and B is equal only to 8, it is obvious that no change can be effected, becauſe the force of affinity between C and B cannot overcome the coheſive force that exiſts between A and B. But if a fourth body D is preſented to the compound A and B, and acts with a force on the body A equal to 6, while the body C acts on B with a force equal to 8, it is evident that the combined action of theſe two forces will overcome the force of affinity between A and B, which was ſuppoſed to be equal to 12, becauſe the meaſure of a force equal to 14 is greater than one equal to 12; and in this way the decompoſition of the body A and B is effected by the united action of two other bodies, which would not have ſucceeded had any one been preſented to it ſingly. From this double action a decompoſition of this kind is called a *double elective attraction*, a name given by Bergman, or a caſe of compound or complex affinity, as it has been propoſed to be denominated by later chemiſts.

Bergman invented a method of exhibiting theſe attractions, as in the following diagram.



In this example the ſubſtances to be decompoſed are placed on the right and left ſides of the diagram. Theſe are the ſulphate of potaſh compoſed of ſulphuric acid and potaſh on the left ſide; and the nitrate of ſilver, which conſiſts of nitric acid and the oxide of ſilver. When theſe compounds are combined together, a decompoſition is effected by the mutual affinities between the conſtituent parts of the compounds. Thus the ſulphuric acid in combination with the potaſh, forms a new compound with the oxide of ſilver; and the nitric acid in combination with the ſilver, forms a new compound with the potaſh; becauſe the ſum of the force of affinities between the nitric acid and the potaſh, and the ſulphuric acid and the oxide of ſilver, is greater than the ſum of the affinities between the ſulphuric acid and the potaſh, and the nitric acid and the oxide of ſilver; and thus an exchange of principles takes place, and the new compounds are repreſented at the top and bottom of the diagram, namely the nitrate of potaſh and the ſulphate of ſilver.

Mr Elliot in the year 1782 propoſed, as an improvement on Bergman's method, to repreſent the force of theſe attractions by numbers. The ſame caſe in Mr Elliot's method is repreſented in the following diagram.

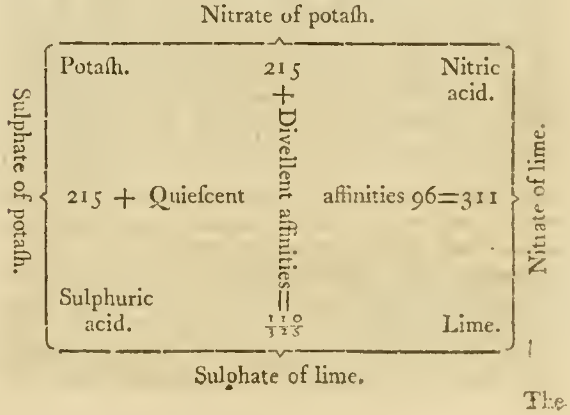


As it is thus repreſented, the ſulphuric acid and the potaſh are ſuppoſed to act with a force equal to 9; and the nitric acid and the oxide of ſilver attract with a force equal to 2. The affinity of the potaſh for the nitric acid is equal to 8; and the affinity between the ſulphuric acid and the oxide of ſilver is equal to 4. But 9+2=11, and 8+4=12, conſequently the ſum of the affinities between the nitric acid and the potaſh, and the ſulphuric acid and the oxide of ſilver, exceeds the ſum of the affinities between the nitric acid and the oxide of ſilver, and the ſulphuric acid and the potaſh, and thus a decompoſition is effected.

117
Two forces to be conſidered.

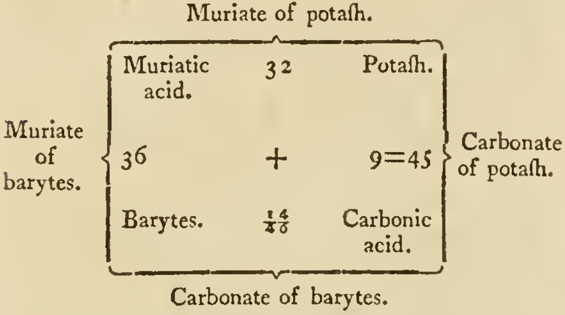
But "in all decompoſitions," ſays Mr Kirwan, "we muſt conſider, firſt, the powers which reſiſt any decompoſition, and tend to keep the bodies in their preſent ſtate; and 2dly, the powers which tend to effect a decompoſition and a new union. The firſt I ſhall call quieſcent affinities, and the ſecond, divellent.

"A decompoſition will always take place when the ſum of the divellent affinities is greater than that of the quieſcent; and on the contrary no decompoſition will happen when the ſum of the quieſcent affinities is ſuperior to, or equal to that of the divellent: all we have to do, therefore, is to compare the ſums of each of theſe powers. Thus, if the ſolutions of ſulphate of potaſh and nitrate of lime be mixed together, a double decompoſition will take place". This may be illuſtrated by the following diagram.



The affinities between the nitric acid and lime, and between the ſulphuric acid and the potaſh, which taken together amount to 311, are the quieſcent affinities. The affinities of the ſulphuric acid and the lime, and of the nitric acid and the potaſh, are the divellent affinities which are oppoſed to the firſt. But the amount of the latter is equal to 325, that is, the combined affinities of the ſubſtances which tend to form a new combination, and thus they overcome the force of the reſiſtance of the quieſcent affinities, as 325 exceeds 311.

Another example will ſerve to make this decompoſition by double or compound affinity ſtill more familiar.



In this caſe a ſolution of muriate of barytes is mixed with a ſolution of the carbonate of potaſh. The affinity of the muriatic acid for the barytes, and that of the potaſh for the carbonic acid, are the quieſcent affinities which are oppoſed to any decompoſing force. But, on the contrary, the affinity of the muriatic acid for the potaſh, and that of the barytes for the carbonic acid, are the divellent affinities. The quieſcent affinities are only equal to 45, while the ſum of the divellent affinities is equal to 46; the latter muſt therefore prevail. The former combinations are broken, and inſtead of muriate of barytes, and carbonate of potaſh, we obtain muriate of potaſh and carbonate of barytes, which latter is inſoluble, and is therefore precipitated.

118 This force not conſtant.

But Berthollet has ſhown that the force of affinity it not conſtant and uniform, but is greatly influenced by the quantity and the ſtate of ſaturation. As, for inſtance, when two baſes act in oppoſition on an acid, the acid divides its action in proportion to their reſpective maſſes. If there be two acids inſtead of one, and no ſeparation take place, either by precipitation or cryſtallization, both acids will act equally on both baſes, in proportion to their maſſes. If each of the acids be previouſly combined with a baſe, and the ſolutions of their ſalts be mixed, the ſum of the reciprocal forces will be the ſame as before. No muriate of potaſh or ſulphate of lime will be formed; but there will be a combination of potaſh, of lime, of ſulphuric and muriatic acid, which will have the ſame degree of ſaturation as before the mixture. And hence it happens, that when two ſalts are mixed together, the mutual decompoſition of which would produce combinations of very different proportions, the ſeparation of the component parts, which ſhould reſult from ſuch decompoſition, is not perceptible. No change of baſes therefore takes place.

The force of coheſion cauſes the ſeparation which takes place by precipitation or cryſtallization. A ſimilar effect is produced by the ſame cauſe, in the action of complex affinities. If a ſolution of ſulphate of potaſh be mixed with muriate of lime, diſſolved in a ſmall quantity of water, the lime brought into contact with the ſulphuric acid, will be more powerfully influenced by the force of coheſion, than the potaſh. This is therefore to be conſidered as an additional force to thoſe which pre-exiſted, and determines the combination of the ſulphuric acid with the lime, and the precipitation of the new compound.

In all decompoſitions effected by compound affinity, the prevailing affinity has been aſcribed to thoſe ſubſtances which have the property of precipitating, or of forming a ſalt which can be ſeparated by cryſtallization. Thus the knowledge of the ſolubility of ſalts which may be formed in a liquid, will point out thoſe ſubſtances which are leaſt ſoluble, and therefore moſt apt to precipitate. To theſe ſubſtances chemiſts formerly aſcribed the ſtrongeſt affinity.

119 Moſt inſoluble compounds precipitate.

Lime, magneſia, ſtrontites, and barytes, form inſoluble ſalts with carbonic acid. When therefore, any of the ſoluble ſalts of theſe earths are mixed with alkaline carbonates, an exchange is produced, from which reſult the formation and precipitation of an earthy carbonate. The compound of ſulphuric acid and barytes forms an inſoluble ſalt. When, therefore, a ſolution of a ſulphate is mixed with that of a ſalt of barytes, a precipitation of ſulphate of barytes, which is inſoluble, will be effected. The ſulphate of lime has alſo but little ſolubility, and conſequently it is much diſpoſed to precipitate. Lime therefore decompoſes all the ſoluble ſulphates. But the ſulphate of lime being much more ſoluble than the ſulphate of barytes, the ſalts of barytes, which are more ſoluble than the ſulphate of lime, decompoſe it.

120 Temperature to be conſidered.

There are other circumſtances which tend to change the action of compound affinities. This action is greatly influenced by the greater or leſs ſolubility of ſalts. But the ſolubility of ſalts is varied by temperature. In eſtimating the reſult of compound affinities, therefore, the degree of temperature muſt be conſidered and taken into the account. To give an inſtance of this effect, nitrate of potaſh mixed with muriate of ſoda, cryſtallizes at a low temperature. During the evaporation the muriate of ſoda is ſeparated. No change of baſes will take place, becauſe the nitrate of ſoda is ſomewhat more ſoluble when cold, than nitrate of potaſh; and muriate of potaſh is more ſoluble when hot, than muriate of ſoda.

The action of complex affinities may alſo be changed by the formation of a triple ſalt which precipitates; but if the ſolubility of the combination be known, the decompoſition which is effected, and the reſulting compounds, may alſo be foreſeen.*

121 Reciprocal action.

According to the theory of Berthollet, all ſubſtances in the liquid ſtate exert a reciprocal action. In a ſolution of ſulphate of potaſh and muriate of ſoda, theſe two ſalts are not diſtinct, nor do they become ſo, until ſome extraneous cauſe produces their ſeparation. Sulphuric and muriatic acids, potaſh and ſoda, are contained in the liquid. To aſcertain what combinations are produced by the force of cryſtallization, he made the following experiments.

122 Force of cryſtallization.

"*Experiment* 1.—A mixture was made of equal parts of nitrate of lime and ſulphate of potaſh: after the ſeparation of the ſulphate of lime formed in the commencement, and of which no further mention ſhall be made in the following experiments, the liquid was evaporated, and nitrate of potaſh and ſulphate of lime were alone obtained by ſucceſſive operations. Yet, after the laſt evaporation, ſome cryſtals of ſulphate of potaſh were obtained: there was but a ſmall reſidue of uncryſtallizable liquid, in which carbonate of ſoda and nitrate of barytes produced precipitations; whence it appears that it conſiſted of a ſmall quantity of ſulphuric acid and lime, and very probably of a larger portion of nitrate of potaſh.

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* *Berthollet's Reſearches*, art. 13.

"The quantity of ſulphate of lime which precipitated during this evaporation, was much greater than what could be diſſolved in an equal quantity of water; whence it appears that its ſolubility was augmented by the action of the other ſubſtances.

"*Experiment* 2.—Two parts of ſulphate of potaſh, and one of nitrate of lime, yielded, by the firſt evaporation, ſulphate of potaſh and ſulphate of lime; and by the following, nitrate of potaſh with the two ſulphates, the proportions of which continued to diminiſh until the ſalts ceaſed to cryſtallize: only a few drops of uncryſtallized liquid remained, in which no precipitate was formed on adding to it ſome carbonate of ſoda, but this effect was produced by the nitrate of barytes; whence it appears probable that the liquid conſiſted of ſulphate of potaſh, and a ſmall proportion of nitrate of potaſh.

"*Experiment* 3.—Two parts of nitrate of lime, and one of ſulphate of potaſh, yielded by the firſt evaporation a ſmall quantity of ſulphate of lime, and on cooling, ſome nitrate of potaſh; by the ſucceeding evaporations nothing but nitrate of potaſh was obtained. After the laſt, however, ſome cryſtals of ſulphate of lime were perceivable on the ſurface of the liquid. Though the reſidue, which was abundant, was repeatedly put to evaporate and cool, no cryſtallization was effected. This uncryſtallizable reſidue, treated with alcohol, yielded an abundant precipitate, in the ſolution of which in water no precipitate could be produced by nitrate of barytes; whence it appears that it contained no ſulphuric acid, and that it was compoſed of pure nitrate of potaſh. What had been diſſolved in the alcohol was nitrate of lime, with a ſmall proportion of nitrate of potaſh: the uncryſtallizable reſidue conſiſted, therefore, of nitrate of potaſh and nitrate of lime.

"It appears that the ſulphate of lime was rendered much leſs ſoluble in this than in the preceding experiments; and that the action of nitrate of lime prevented a conſiderable quantity of the nitrate of potaſh from cryſtallizing.

"Sulphate of lime was neceſſarily formed in theſe three experiments, becauſe its component parts were in contact; and the inſolubility of the compound formed by them, occaſioned its precipitation to a certain extent.

"In the firſt and ſecond experiments, the ſulphate of lime was rendered much more ſoluble than it naturally is, by the action of the ſubſtances in ſolution; but in the third experiment, its ſolubility was not perceptibly increaſed, for this reaſon, probably, that the nitrate of lime and nitrate of potaſh, which exiſted in the uncryſtallizable liquid, had mutually ſaturated each other ſo much as to diminiſh their action on the ſulphate of lime *.

From theſe conſiderations, he deduces the theory of uncryſtallizable reſidues: which the ſucceeding obſervations tend to confirm.

"Saline ſubſtances exert a mutual action, which augments their ſolubility; as has been proved by the experiments publiſhed by my learned colleague Vauquelin. This reciprocal action varies in different ſalts; it was once ſuppoſed that the ſolubility of the nitrate of potaſh was not augmented by the action of earthy ſalts; and yet it is augmented more by them than by any others.

"There muſt be, doubtleſs, in this reſpect, ſome difference ariſing from the nature of the ſalts, in the effect which they produce; but this difference is, in general, very trifling, compared to that reſulting from the force of cryſtallization.

"*Experiment* 4.—A mixture of equal parts of nitrate and ſulphate of potaſh, yielded by evaporation, and ſucceſſively, according to their ſolubility, ſulphate of potaſh and nitrate of potaſh, without leaving any uncryſtallizable reſidue; but having made a ſimilar experiment with a mixture of nitrate and ſulphate of ſoda, each of which has but a feeble tendency to cryſtallize, and nearly an equal degree of ſolubility, there was ſeparated by cryſtallization but a ſmall portion of the ſulphate of ſoda, the other parts of the mixture continuing in the liquid ſtate, incapable of being cryſtallized by any means. Muriate of ſoda and ſulphate of alumine, ſubmitted to the ſame treatment, were perceived to become more ſoluble; but they were totally ſeparated in the end by alternate evaporation and cooling.

"It appears, then, that ſubſtances which are endued with an active tendency to cryſtallize, though rendered more ſoluble than they naturally are, ſeparate however in the order of their inſolubility, without leaving any, or but very little, uncryſtallizable reſidue.

"But when a mixture conſiſts of ſalts which have but a weak tendency to cryſtallize, their mutual action counteracts that tendency, ſo that a large portion of uncryſtallizable liquid remains: this effect is ſtill more complete when the mixture contains a ſubſtance naturally uncryſtallizable, as in the third experiment, in which there was an exceſs of nitrate of lime, the action of which exceſs on the nitrate of potaſh rendered a great portion of it uncryſtallizable." †

From this it appears, Berthollet obſerves, that the formation of ſalts obtained by cryſtallization, depends on the proportions of the ſubſtances which act on each other; and combinations may be formed which vary from the proportions of the ſubſtances employed, or the ſtage of the operation; that is, from the proportions which continue in action, when the combinations which might take place are not endued with a force of coheſion ſufficient to withdraw them from the ſphere of action.

Ninth Law.

123. Affinity diminiſhes towards the point of ſaturation.

Affinity is in the inverſe ratio of ſaturation.

In moſt of the combinations which take place between bodies, there exiſts a certain determinate proportion of the quantity of the ſubſtances which form the compound. On this indeed depend the conſtancy

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* Bertholet's Reſearches, art. 13.

† Ibid.

and permanency, both of natural and artificial compounds. It is to this uniformity and permanency that their characteriſtic properties are owing; for when the proportions in compound bodies vary, although the conſtituent parts be of the ſame nature, yet the properties of the compound are greatly changed. Thus, in a caſe already mentioned, the different proportions of oxygen with lead, different compounds are produced; with a ſmaller proportion of oxygen, the reſulting compound is yellow, but with a greater it is red.

124 Saturation. As there are certain limits to the proportions in which bodies combine together, beyond which they cannot paſs, theſe are called the points of *ſaturation;* and when two bodies, in uniting together, have reached this point, they are ſaid to be ſaturated, or the one body is ſaid to be ſaturated with the other: in other words, the change has taken place, and a new compound is formed. When, for inſtance, a ſalt is diſſolved in water, as common ſalt, the water combines only with a certain proportion; and whatever quantity of ſalt is added beyond this proportion, it falls to the bottom undiſſolved. The reaſon of this is, that the particles of the ſalt are held together by their affinity for each other; that is, by the force of coheſion. Now, before any combination can be effected between the particles of the ſalt and the water, this force muſt be overcome. The force of affinity, therefore, between the water and the particles of ſalt, is greater than that between the particles of ſalt themſelves, and thus they are ſeparated and diſſolve in the water: but this force of affinity between the water and the ſalt is limited; and when it has arrived at its utmoſt limit, the action between the two bodies ceaſes. The two forces which were oppoſed to each other; that is, the force of affinity between the water and the ſalt on the one hand, and the force of coheſion between the particles of the ſalt on the other, are balanced. The water in this caſe is ſaid to be ſaturated with ſalt.

125 In different proportions. In a ſenſe ſomewhat ſimilar, the word *neutralization* has been employed. When to an acid there is added the ſolution of an alkali to a certain point, they combine together, and form a compound, in which the properties of the acid and of the alkali totally diſappear. They are then ſaid to have neutralized each other; and hence the name of *neutral ſalts*, which has been given to theſe compounds.

Some bodies, it would appear, enter into combination with others, only in one determinate proportion, and ſome in two proportions, and theſe proportions are denominated their *maximum* and *minimum* of ſaturation; that is, the ſmalleſt and greateſt proportions in which they combine with each other. There is another ſet of bodies which combine in any proportion between the higheſt and the loweſt points, while a fourth ſet combine only in certain determinate proportions between theſe points.

Now, from theſe obſervations, let us endeavour to illuſtrate the meaning of this law, by attending to what takes place in the different combinations of bodies with each other. A ſmaller quantity of ſalt diſſolved in a given quantity of water, is held in combination by a greater force of affinity, than a greater quantity; becauſe this force is to be eſtimated by the affinity which exiſts between the ſalt and the water, and its maſs. The nearer, therefore, it comes to the maximum or higheſt point of ſaturation, the weaker is the affinity between the water and the ſalt; and in approximating to this point, this force is gradually diminiſhed.

When two bodies combine together in two different proportions, or what are called the maximum and minimum points of ſaturation, the force of affinity is greateſt between the two bodies, at the loweſt point. Suppoſe that two bodies, A and B, can enter into combination with each other, in two different proportions. Suppoſe the quantity of A is = 20 grs. and the firſt portion of B which combines with it is = 10 grs.: it is evident from this combination, that part of the force of the affinity of A is exhauſted, but ſtill it combines with another portion of B; ſuppoſe this is = 5 grs. and then it has reached its higheſt point of ſaturation, or the maximum. But as the laſt portion of B, which combined with A, is retained in the compound by the force of affinity in A, which remained after its combination with the firſt portion of B, it is obvious that this force muſt be greatly diminiſhed, and therefore the laſt portion of B will be moſt eaſily ſeparated from its combination with A; and this accordingly is found to hold in all caſes.

TENTH LAW.

Between two compound bodies which are not acted on by compound affinity, decompoſition may take place, if the affinity of two of the principles for a third be greater than that which unites this third to one of the two firſt, although, at the moment of action, the union between the two firſt does not exiſt.

126 Diſpoſing affinity. This is called *diſpoſing* or *prediſpoſing* affinity, becauſe no change takes place without the influence or action of a third body on ſome of the compounds; for it is this action which operates the formation of the compound, and the decompoſition of another compound, without the formation of the firſt. To have a clear conception of this diſpoſing affinity, let us ſuppoſe that there are two compounds AB and CD; the affinity of whoſe conſtituent parts, that is, the affinity between A and C, and the affinity between B and D, is not greater than the affinity which exiſts between AB and CD. In this caſe, it is obvious that no decompoſition can be effected by compound affinity, becauſe the ſum of the quieſcent affinities exceeds the ſum of the divellent; but if the force which tends to combine B and C together, added to that which tends to unite the compound BC to D, be greater than the force of coheſion between the compounds AB and CD, the reſult of this action will be a decompoſition, the formation of a new compound BCD, and the ſeparation of the firſt component part A.

Water is compoſed of two ſubſtances, which have received the names of oxygen and hydrogen. Sulphur has no direct action on water. This ſhews that the affinity between ſulphur and any of the conſtituent parts of the water, is not ſo great as the affinity of the oxygen and hydrogen for each other; but if ſulphur be united with an alkali, the water is decompoſed by this combination, although there is no affinity between the alkali and the oxygen. The ſulphur combines with the oxygen of the water, and forms ſulphuric acid. It is this attraction which favours the decompoſition of the water, and is therefore called a *prediſpoſing affinity*.

Such then are the phenomena of chemical action, which have been obſerved and claſſed together. The knowledge of the laws of affinity, and the knowledge of chemiſtry, may be regarded as ſynonymous terms, becauſe it is by the obſervation of the laws by which the changes that take place among bodies by chemical affinity are produced, that this ſcience can be improved and extended. The detail of chemical ſcience, therefore, may be regarded as the hiſtory of affinities. We therefore proceed, in the following chapters, to examine the properties of thoſe bodies, the knowledge of which belongs to chemical ſcience; the changes which take place by the action of affinity, and the new compounds which are the reſult of theſe changes; and, at the ſame time, to point out ſome of their applications and uſes.

Chap. II. Of LIGHT.

Light and heat, which are to be treated of in this and the ſucceeding chapters, are highly intereſting, not only as curious ſubjects of ſpeculation, but as acting a very important part in the changes which are conſtantly going on among natural bodies. Indeed no change happens, in which the one or the other, and ſometimes both, is not either abſorbed or extricated.

Light, of which we are now to treat, is the principal agent, in many chemical proceſſes; and this, as well as the aſtoniſhing velocity of its motions, and the properties which it has of penetrating and traverſing ſubſtances with which it comes in contact, render it an object worthy of great attention.

127 Opinions of the nature of light.

128 An undulating fluid.

Light, if it could be defined, is too familiar to every one to require any definition. It is by the light of the ſun, or that which proceeds from burning bodies, that we are informed of the preſence of objects; or the rays of light proceeding from theſe bodies, and entering the eye, produce the ſenſation of viſion. We have no certain knowledge concerning the nature of light. Various conjectures, however, have been made, and various theories have been propoſed, with regard to it. Two of theſe we ſhall only mention. According to Des Cartes, Huygens, and ſome other philoſophers, all ſpace is filled up with a very ſubtile fluid, and this fluid is agitated or put in motion by the ſun, or burning bodies. This motion conſiſts of vibrations or undulations, which, extending themſelves and reaching the eye, render the bodies which have produced theſe motions viſible.

129 Material.

The other theory is that of Newton and his followers. According to this theory, light is ſuppoſed to be a real emanation from luminous bodies; that is, a ſubtile fluid, conſiſting of peculiar particles of matter which are conſtantly ſeparating from luminous bodies, and, by entering the eye, excite the ſenſation of light, or the perception of the objects from which it proceeds, or thoſe from which it is reflected. This theory, which has been deduced from a great number of facts and obſervations, was eſtabliſhed by Newton by mathematical demonſtration. If then it be admitted, that light is a ſubtile fluid, conſiſting of minute particles, ſeveral conſequences follow, which require explanation, with regard to the ſize, the velocity, and the momentum of theſe particles. In what follows, we ſhall conſider light with regard to its phyſical properties; its chemical properties, or the effects it produces on bodies with which it enters into combination; and, laſtly, the ſources from which it is obtained.

Sect. I. *Of the Physical Properties of Light.*

130 Velocity

131 diſcovered.

132 Confirmed.

1. One of the moſt aſtoniſhing properties of light is its velocity. It has been obſerved by aſtronomers, that the eclipſes of the ſatellites of the planet Jupiter appear to take place ſooner, when that planet is neareſt to the earth, and later when Jupiter is on the oppoſite ſide of his orbit from the earth. Roemer, a Daniſh aſtronomer, in attempting to account for this apparent anomaly, proved that it was owing to the difference of time which the particles of light required, to paſs through the ſemidiameter of Jupiter's orbit: and from this he demonſtrated, that the particles of light move through one half of the diameter of the earth's orbit in about eight minutes. This diſcovery of Roemer has been fully confirmed by the theory propoſed by Dr Bradley, to account for the aberration of the light of the fixed ſtars. From theſe data it has been computed, that light moves with the velocity of 200,000 miles in a ſecond;—a velocity of which the human mind can form no diſtinct conception. But in comparing this velocity with that of a cannon ball, it may be obſerved, that light paſſes through a ſpace in about eight minutes, which a cannon ball with its ordinary velocity could not traverſe in leſs than thirty-two years!

133 Particles very minute.

2. From the remarkable velocity of light, may be inferred the extreme minuteneſs of its particles. The force with which moving bodies ſtrike, is in proportion to their maſſes, multiplied by their velocities. If, therefore, the one or the other, or both, be increaſed, the ſtriking force is proportionally augmented; and conſequently, if the particles of light were not extremely ſmall, their exceſſive velocity would be highly deſtructive. Indeed, were they equal in bulk to the two millionth part of a grain of ſand, this impulſe would not be leſs than that of ſand ſhot from the mouth of a cannon.

The minuteneſs of the rays of light may be alſo demonſtrated from the great facility with which they penetrate and paſs through tranſparent ſolid bodies. In moving through ſuch bodies, light ſeems not to ſuffer the ſmalleſt diminution of its velocity. If there is nothing to obſtruct the rays of light which proceed from a candle, it will fill the whole ſpace within two miles around, almoſt inſtantaneouſly, before it has loſt any ſenſible part of its ſubſtance.

134 Reflection.

3. When a ray of light falls on a poliſhed ſubſtance in a perpendicular direction, it is thrown back in the ſame direction; but when a ray of light falls on the ſame body obliquely, it returns from the ſurface on the oppoſite ſide of a perpendicular line drawn from the point on which the ray falls, and at an equal diſtance from that perpendicular. The angle which the ray of light forms with the perpendicular as it falls, is equal to the angle which it forms with the ſame line, when it is thrown back. The firſt angle is called the *angle of incidence*, and the ſecond the *angle of reflection*.

Hence the optical law, that the angle of incidence is equal to the angle of reflection. When the rays of light fall obliquely on poliſhed ſurfaces, they are reflected before they touch theſe ſurfaces, which is ſuppoſed to be owing to a repulſion between the particles of light and the particles of the poliſhed body. But when rays of light fall obliquely on a tranſparent ſubſtance, as a plate of glaſs, they paſs through to the other ſide, and then return to the ſame ſurface, and are reflected.

135 Inflection.

4. When a ray of light is admitted into a dark room, through a ſmall hole, it forms a luminous ſpot on any object oppoſite to that from which the light proceeds; and if the blades of two knives are placed on oppoſite ſides of the hole, having their planes parallel to the plane of the window ſhutter or paſteboard through which the ray paſſes, when the edges of the knives are brought near each other, the rays of light are drawn from their former direction towards the edges of the knives, and the luminous ſpot appears enlarged. This is called the *inflection* of light. A ſimilar effect is produced by nearly ſhutting the eyes, and looking at a candle. The rays of light appear to proceed from it in various directions; for the light, in paſſing through the eye-laſhes, is inflected, and is divided into ſeparate beams, diverging from the luminous object.

136 Refraction.

5. A ray of light paſſing from one medium to another, moves on in the ſame direction; as for inſtance, when light paſſes from air to water, or from water into air; but if a ray of light paſſes in an oblique direction from one medium to another, it is bent from its former courſe, and then moves on in a new direction: this is called the *refraction* of light. A ſtraight rod, which is introduced obliquely into a veſſel of water, appears bent at the place where it touches the ſurface of the water. This is owing to the refraction of the rays of light paſſing from the rarer medium of the air to the denſer medium of the water.

When the light paſſes into a medium of greater denſity, as for inſtance from air into water, it is refracted or bent towards the perpendicular; but when it paſſes from a denſer into a rarer medium, as from water into air, it is refracted from the perpendicular. The meaſure of the quantity of this refraction is eſtimated by the denſity of the medium; with this exception, however, that if the medium be a combuſtible ſubſtance, the refractive power is then found to be greater. It was from the obſervation of this law of the refraction of light, that the conjecture which was thrown out by Newton, of the combuſtible nature of water and the diamond, which has been verified by the diſcoveries of modern chemiſtry, occurred to the mind of that ſagacious philoſopher.

137 Spectrum

6. When a ray of light is admitted through a ſmall hole, and received on a white ſurface, it forms a luminous ſpot. If a denſe tranſparent body be interpoſed, the light will be refracted, in proportion to the denſity of the medium; but if a triangular glaſs priſm be interpoſed, the light is not merely refracted, but it is divided into ſeven different rays. The ray of light no longer forms a luminous ſpot, but has aſſumed an oblong ſhape, terminating in ſemicircular arches, and exhibiting ſeven different colours. This image is called the ſpectrum, and, from being produced by the priſm, the *priſmatic ſpectrum*. Theſe different coloured rays appearing in different places of the ſpectrum, ſhew that their refractive power is different. 138 Of ſeven colours. Thoſe which are neareſt the middle are the leaſt refracted, and thoſe which are the moſt diſtant, the greateſt. The order of the ſeven rays of the ſpectrum is the following: RED, ORANGE, YELLOW, GREEN, BLUE, INDIGO, VIOLET. The red, which is at one end of the ſpectrum, is the leaſt, and the violet, which is at the other end, is the moſt refracted.

Sir Iſaac Newton found, if the whole ſpectrum was divided into 360 parts, the number of the parts occupied by each of the colours to be the following:

Red,	45 parts.
Orange,	27
Yellow,	48
Green,	60
Blue,	60
Indigo,	40
Violet,	80

139 Not farther diviſible.

Theſe different coloured rays are not ſubject to farther diviſion. No change is effected upon any of them by being farther refracted or reflected; and, as they differ in refrangibility, ſo alſo do they differ in the power of inflexion and reflexion. The violet rays are found to be the moſt reflexible and inflexible, and the red the leaſt.

7. Light, it is well known, ſeems to ſuffer no interruption in paſſing through ſome bodies; ſuch are glaſs or water, but it is interrupted in its paſſage through other bodies, as a piece of wood or ſtone. The firſt ſet of bodies are called *tranſparent*, and the other *opaque*. The denſity of water or of glaſs is greater than that of a piece of wood. It cannot therefore be owing to the denſity of the latter, or the cloſeneſs of the particles which compoſe it, that the tranſmiſſion of light is prevented. 140 Tranſparency. In the explanation which has been given by Newton, it is ſuppoſed that the particles which compoſe tranſparent bodies, are of equal denſity, and are uniformly arranged: but in opaque bodies he ſuppoſes the particles are of unequal denſity, or are not uniformly arranged. From the uniform arrangement and equal denſity which, according to this explanation, are ſuppoſed to exiſt in tranſparent bodies, the light paſſing through them moves in a ſtraight line, becauſe it is equally attracted by the particles of the body. 141 Opacity. But in the latter (the opaque bodies) the attraction between light and the particles of the body is unequal; its direction is conſtantly changing, till at laſt it is entirely interrupted.

142 Illuminating power.

8. Dr Herſchel, who has made ſome intereſting diſcoveries concerning light and heat, found that the illuminating power of the different rays was different. From the obſervations which he made on this ſubject, he ſays, that "with reſpect to the illuminating power aſſigned to each colour, we may conclude, that the red-making rays are very far from having it in any eminent degree. The orange poſſeſs more of it than the red, and the yellow rays illuminate objects ſtill more perfectly. The maximum of illumination lies in the brighteſt yellow, or paleſt green. The green itſelf is nearly equally bright with the yellow; but from the full deep green the illuminating power decreaſes

creaſes very ſenſibly; that of the blue is nearly upon a par with that of the red; the indigo has much leſs than the blue; and the violet is very deficient*."

Sect. II. *Of the Chemical Properties of Light.*

143
Light enters bodies.

1. From the properties of light which have now been detailed, it appears that it is ſubject to the univerſal law of attraction, as well as other bodies; but it is alſo found to enter into chemical combination with many ſubſtances. Theſe ſubſtances, it has been diſcovered by experiment, after being for ſome time expoſed to the light, and carried into a dark place, appear luminous. It is found, however, that this property is loſt when they are kept in the dark, and they do not recover it till after they have been again expoſed to the light. Some ſubſtances poſſeſs this property in a greater degree than others. One, which was diſcovered by Mr Canton, who made a number of experiments on this phoſphoreſcent light, as it has been called, is prepared by the following proceſs. He took ſome oyſter-ſhells and calcined them, after which they were reduced to powder, and the pureſt part of them was put through a fine ſieve. Three parts of this powder were mixed together with one part of the flower of ſulphur; the mixture was put into a crucible, and firmly preſſed to the bottom, which was then expoſed for an hour to a red heat. It was then removed from the fire, and when it cooled, the pureſt parts of the mixture were ſcraped off, and put up in a well-cloſed phial. This is called Canton's pyrophorus. When this is expoſed to the light for a ſhort time, it becomes ſo luminous that objects may be diſtinctly perceived in the dark, by the light which it emits. It loſes this property, however, by being kept in the dark, but recovers it again when it is expoſed to the light. And, after being kept in the dark for ſome time, the light from the pyrophorus becomes feeble, or is nearly extinct, but it may be revived or increaſed by plunging the phial into hot water. But if the whole of the light has been ſeparated previous to the application of heat, no farther application can cauſe it to emit light, till it has been expoſed to a luminous body. Thus it appears that light enters into combination with other bodies, and that it afterwards leaves them without having undergone any perceptible change.

144
Canton's pyrophorus.

145
From which light is again emitted.

2. If a quantity of purple-coloured fluate of lime (Derbyſhire ſpar) be reduced to coarſe powder, and expoſed to heat in a dark place, it emits a great quantity of coloured light; but when this light which has been in combination with the ſpar is once expelled, it does not recover its property of ſhining in the dark, as in the caſe of Canton's pyrophorus.

146
Suppoſed to be ſlow combuſtion.

It has been ſuppoſed by ſome, that the light, emitted by theſe ſubſtances is the conſequence of ſlow combuſtion; but many of the ſubſtances which have this property are not combuſtible, and none of the changes which take place during this proceſs have been obſerved. In ſome caſes it would appear that the light which is given out is different from that to which they were expoſed, and which they muſt have abſorbed. In ſome of the pyrophori, the blue rays were obſerved to have a greater effect, and the light which was emitted was of a red colour.

147
Emitted by animal matters, &c.

3. Light, it is well known, is given out by a number of animal and vegetable matters, when the proceſs of putrefaction commences. In this caſe it ſeems to conſtitute one of their component parts. This particularly happens to fiſh of different kinds, as the herring and the mackerel, and to this is ſuppoſed to be owing the phoſphoreſcent light of the ſea, which appears when the water is broken and agitated. Theſe phenomena were obſerved by Mr Boyle and Dr Beale, both in the fleſh of quadrupeds and fiſhes, and earlier by Fabricius ab Aquapendente and Bartholin in the fleſh of quadrupeds. Experiments were made on the ſame ſubject by Mr Canton, whom we have already mentioned, and more lately by Dr Hulme. From the experiments of the latter he concludes, that this light is a conſtituent principle of marine fiſhes; that it is incorporated with their whole ſubſtance, making a part of it, in the ſame manner as any other conſtituent principle; that when this ſpontaneous light is extinguiſhed by ſome ſubſtances, it may be again revived; that the quantity of light emitted is not in proportion to the degree of putrefaction, but, on the contrary, the greater the putreſcence, the leſs is the quantity of light emitted.

148
A conſtituent principle.

For the ſake of thoſe who may wiſh to repeat theſe experiments, we ſhall detail the following made on the herring and the mackerel, in the words of the author.

The Fleſh of Herring (G.)

149
Dr Hulme's experiments.

(1.) "A freſh herring was ſplit, or divided longitudinally by a knife, into two parts. Then about four drams of it, being cut acroſs, were put into a ſolution, compoſed of two drams of Epſom ſalt or vitriolated magneſia, and two ounces of cold ſpring water drawn up by the pump. The liquid was contained in a wide-mouthed three-ounce phial, which was placed in the laboratory. Upon carefully examining the liquid, on the ſecond evening after the proceſs was begun, I could plainly perceive a lucid ring (for the phial was round) floating at the top of the liquid, the part below it being dark; but on ſhaking the phial, the whole at once became beautifully luminous, and continued in that ſtate. On the third evening, the light had again riſen to the top; but the lucid ring appeared leſs vivid, and, on ſhaking the phial as before, the liquid was not ſo luminous as on the preceding night.

(2.) The ſame experiment was repeated. On the ſecond night, the liquid, being agitated, was very luminous; on the third, not ſo lucid; and on the fourth the light was extinguiſhed.

(3.) With ſea ſalt or muriated natron half a dram, and two ounces of water. On the ſecond night, the liquid, when agitated, was dark; on the third, lucid; on the fourth very luminous; on the fifth, it began to loſe light; on the ſixth, it continued to decreaſe; and on the ſeventh it was quite gone. Neither the liquid, nor the herring, had contracted any putrid ſmell.

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* Philoſ. Tranſ. vol. xc. p. 26.

(G) The quantity uſed in each experiment was about four drams.

(4.) With ſea water two ounces. On the ſecond night, dark; on the third, fourth, and fifth, luminous; on the ſixth, nearly extinct; and on the ſeventh, totally. The piece of herring, when taken out and examined, was remarkably ſweet.

Roe of Herring (H).

(5.) With Epſom ſalt two drams, and water two ounces. On the ſecond night, the liquid was pretty luminous; on the third and fourth, ſtill luminous; and on the fifth its light was extinct.

(6.) With Glauber's ſalt or vitriolated natron, two drams to two ounces of water. On the ſecond night, when the phial was ſhaken, as uſual in all theſe experiments, the liquid was pretty luminous; on the third, leſs ſo; and on the fourth the light was ſcarcely viſible.

(7.) With ſea water two ounces. On the ſecond night, dark; on the third, the liquid was moderately luminous; on the fourth and fifth, it had extracted much light; and on the ſeventh it was ſtill ſhining. After this proceſs, both the roe and the ſea water remained perfectly ſweet.

The Fleſh of Mackerel.

(8.) With Epſom ſalt two drams, and water two ounces. On the ſecond night, the liquid was finely illuminated; on the third, a ſimilar appearance; on the fourth, a diminution of light; on the fifth, it continued lucid in a ſmall degree; and on the ſixth the light was extinguiſhed.

Roe of Mackerel.

(9.) With Epſom ſalt two drams, and water two ounces. On the ſecond night, the liquid, when agitated, was exceedingly bright; on the third, the ſame; and on the fourth and fifth, ſtill lucid †."

Dr Hulme found that ſome ſubſtances have the power of extinguiſhing this light. It was quickly extinguiſhed when mixed with water alone, with water impregnated with lime, carbonic acid gas, or ſulphurated hydrogen gas; by fermented liquors and ardent ſpirits; by the acids, both concentrated and diluted; by the alkalies when diſſolved in water; by many of the neutral ſalts, as the ſolutions of common ſalt, Epſom ſalt, and ſal ammoniac. It was alſo extinguiſhed by infuſions of chamomile flowers, of long pepper and of camphor made with boiling hot water, but not uſed till quite cool.

When the ſubſtances emitting this light were placed in a freezing medium, the light was in a ſhort time quite extinguiſhed; but when expoſed to a moderate degree of temperature, it was revived. A moderate degree of heat increaſed this light, but it was extinguiſhed by a high temperature, and no luminous appearance could again be diſcovered.

150 Colour.

4. When all the rays of light are reflected from any body, that body is ſaid to be white; but when all the rays are abſorbed, the body which abſorbs them is ſaid to be black: but experience informs us, that different bodies abſorb and reflect different rays. Thus, if a body abſorb all the rays excepting the yellow, that body is ſaid to be of a yellow colour; or if a body reflect the red rays, while the others are abſorbed, it is ſaid to be red. Thus the colour of the body is characterized by the colour of the ray which is reflected; or, which is the ſame thing, this is the cauſe of colouring bodies.

151 Effects of light on metallic oxides and ſalts.

5. One of the moſt ſingular effects which is obſerved in the combination of light with bodies, is its power of reducing the oxides of the metals. Some of theſe, as for inſtance, the red oxide of lead, when expoſed to the light of the ſun, loſe ſome of their weight. The oxide of gold may alſo be reduced in the ſame way, and the white ſalts of ſilver become black, and the oxide is reduced; and when that proceſs is going on, oxygen gas is emitted, which, it would appear, has been ſeparated by the action of light. Some of the rays are found to have a greater effect than others. Scheele, who made a ſet of experiments to aſcertain the difference of effect of the different-coloured rays in blackening the muriate of ſilver, diſcovered that the violet ray was the moſt powerful in reducing the oxide of ſilver.

152 Peculiar rays.

It was formerly the general opinion, that the colorific rays of light were the cauſe of the reduction of the oxides of the metals, but the experiments and obſervations of Meſſrs Bockman and Ritter in Germany, and of Dr Wollaſton in England, prove that the muriate of ſilver is more ſtrongly and rapidly darkened by rays of the ſun which have been more refracted than the violet rays; for it appeared that the muriate was affected in a ſpace lying beyond the violet light. Theſe rays, therefore, have not the property of giving light, nor do they produce any ſenſible degree of heat; and thus it appears that there are three different ſets of rays; namely, rays which illuminate, rays which warm without giving any light (I), and rays which produce a chemical action on bodies, but which give neither light nor heat. From the conſideration of theſe curious and intereſting experiments, it has been very naturally ſuppoſed, that the chemical actions dependent on ſolar light are owing to the inviſible rays which were refracted beyond the violet rays; and that the colorific rays have no ſhare in theſe actions: for it has been obſerved, that the effect of the different colours increaſes with their refrangibility; and that the whole is owing to the inviſible rays, which increaſe in number or quantity as they approach to the violet ray, and are in greateſt quantity at a certain diſtance beyond it.

153 Light abſorbed by plants.

6. The abſorption of light by plants produces another remarkable effect. It has been long known, that the green colour of the leaves of plants is produced by the light of the ſun. Experiments were firſt made to aſcertain this fact by M. Dufay and ſome others of the French academicians. The ſubject has been farther proſecuted and extended by Senebier of Geneva. When ſeeds are ſown in a dark place, they vegetate,

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† Phil. Tranſ. 1800. p. 168.

(H) The quantity uſed in each experiment was about four drams.

(I) Theſe will be particularly mentioned in the next chapter.

getate, and the plant grows with conſiderable luxuriance; but it never has any green colour as long as the light is excluded; the leaves continue white; and this happens although air be freely admitted. When the plant in this ſtate is expoſed to the light, the green colour begins to appear, and the plant aſſumes its ordinary habit. It may be added, that while the plant remains white, it contains but a ſmall quantity of combuſtible matter, and it has but little taſte. When it aſſumes the green colour after its expoſure to the light, it acquires its natural taſte, and the ordinary quantity of combuſtible matter. It is upon this principle that the art of blanching celery and other garden plants depends; by heaping up the earth about the ſtems the light is excluded, and thus they are deprived of any pungent taſte, and become white and tender (K).

SECT. III. *Of the Sources of Light.*

154
The ſun.

1. The principal ſource of light is the ſun. It has been a queſtion of more curioſity than utility, what is the cauſe of the ſun conſtantly emitting light, and what are the means of repairing that waſte? By calculations it is ſuppoſed, that there ought to iſſue from one ſquare foot of the ſun's ſurface in one ſecond, $\frac{1}{400000}$th part of a grain of matter, to ſupply the conſumption of light; that is, at the rate of little more than two grains a-day, or about 4,752,000 grains, or 670lb. in 6000 years, which would have ſhortened the ſun's diameter about 10 feet, if it was formed of matter of the denſity of water only.*

* *Prieſtley's Optics,* p. 389.

But at the time this calculation was made, the diſcoveries of Herſchel, of the conſtitution of the ſun, were not known. The body of the ſun, according to the obſervations of this philoſopher, is not luminous, but opaque; and the light which was ſuppoſed to come from his ſurface, proceeds from a luminous atmoſphere which ſurrounds that body; and there are probably ſome means by which the waſte that is conſtantly going on, is repaired. The light which comes from the ſtars is of the ſame nature with that of the ſun.

155
Combuſtion

2. Another ſource of light are burning bodies. In all caſes of burning, light is emitted. This light, therefore, muſt have been in combination with ſome of the ſubſtances which are employed in theſe proceſſes.

156
Heat.

3. But when bodies, without undergoing the proceſs of combuſtion, are heated to a certain temperature, they emit light: and it would appear, from experiments which have been made upon the ſubject, that all bodies which are not decompoſed before they arrive at the proper temperature, begin to give out light, exactly at the ſame degree of heat. Iron heated to 635°, according to Sir Iſaac Newton's experiments, becomes viſible in the dark; at 752° it ſhines brightly; and becomes luminous in the twilight at 884°. The temperature is above 1000° when it ſhines in broad day light. A red heat, according to the experiments of others, commences at the temperature of 800°, and when a body reaches the proper degree of heat, it appears luminous, independent of the air. Mr T. Wedgwood, who made a number of experiments on this ſubject, found that a piece of iron wire became red hot when immerſed in melted glaſs. Air, therefore, is not neceſſary to the ſhining of ignited bodies.

It was alſo aſcertained by Mr Wedgwood, that a piece of red-hot metal continues to ſhine for ſome time after it has been removed from the fire, which proves that conſtant acceſſions of light or heat are not neceſſary for the ſhining of ignited bodies. But if the red-hot metal be ſtrongly blown upon, it inſtantly ceaſes to ſhine, and thus, it appears when the temperature is diminiſhed, it ceaſes to give out light †.

† *Phil. Tranſ.* vol lxxii. p. 279.

From

(K) This is remarkably illuſtrated by the following obſervation of Profeſſor Robiſon. "Having occaſion in autumn 1774, to go down and inſpect a drain in a coalwork, where an embankment had been made to keep off a lateral run of water, and, crawling along, I laid my hand on a very luxuriant plant, having a copious, deep-indented, white foliage, quite unknown to me. I inquired of the colliers what it was. None of them could tell me. It being curious, I made a ſod be carried up to the daylight, to learn from the workmen what ſort of a plant it was. But nobody had ever ſeen any like it. A few days after, looking at the ſod, as it lay at the mouth of the pit, I obſerved that the plant had languiſhed and died, for want of water, as I imagined. But looking at it more attentively, I obſerved that a new vegetation was beginning, with little ſproutings from the ſame ſtem, and that this new growth was of a green colour. This inſtantly brought to my recollection the curious obſervations of M. Dufay; and I cauſed the ſod to be ſet in the ground and carefully watered. I was the more incited to this, becauſe I thought that my fingers had contracted a ſenſible aromatic ſmell by handling the plant at this time. After about a week, this root ſet out ſeveral ſtems and leaves of common tanſy. The workmen now recollected that the ſods had been taken from an old cottage garden hard by, where a great deal of tanſy was ſtill growing among the graſs. I now ſent down for more of the ſame ſtuff, and ſeveral ſods were brought up, having the ſame luxuriant white foliage. This, when bruiſed between the fingers, gave no aromatic ſmell whatever. All theſe plants withered and died down, though carefully watered, and, in each, there ſprouted from the ſame ſtocks freſh ſtems, and a copious foliage, and produced, among others, common tanſy, fully impregnated with the ordinary juices of that plant, and of a full green colour. I have repeated the ſame experiment with great care on lovage (*leviſticum vulgare*), mint, and caraways. All theſe plants throve very well below, in the dark, but with a blanched foliage, which did not ſpread upwards, but lay flat on the ground; in all of them there was no reſemblance of ſhape to the ordinary foliage of the plant; all of them died down when brought into daylight; and the ſtocks then produced the proper plants in their uſual dreſs, and having all their diſtinguiſhing ſmells.

From ſuch experiments, I thought myſelf entitled to ſay that the ſun's rays not only produced the green fæcula of plants, but alſo the diſtinguiſhing juices, and particularly the eſſential oils. The improvements which have been made in chemical ſcience ſince that time, have, I think, fully confirmed my conjecture," *Black's Lect.* i. 533.

157 Gaſes not luminous.

From the experiments of Mr Wedgwood, it appears that the gaſes do not become luminous, even at a higher temperature. He took an earthen-ware pipe of a zig-zag form, and placed it in a crucible filled up with ſand. The ends of the pipe were left uncovered. To one end was attached a pair of bellows, and to the other a globular veſſel with a lateral bent pipe, to let out air, but exclude the external light, and having a neck in which was inſerted a circular plate of glaſs. The crucible, with the ſand and the part of the pipe contained in it, was heated to redneſs. The eye was fixed in the neck of the veſſel, which was then obſerved to be perfectly dark within. A ſtream of air was then directed through the tube from the bellows, but this air which paſſed through the red-hot tube, was not luminous. A ſmall ſtrip of gold was then fixed into the orifice of the tube oppoſite to the eye, and after two or three blaſts, it became faintly red; which ſhows, that though the air was not luminous, it was equal in temperature to what is called red heat. Dr Darwin made an experiment of the ſame kind, and with a ſimilar reſult. The heated air was altogether inviſible; but when a bit of gold was introduced, it acquired a bright glow in a few ſeconds *.

158 Attrition and percuſſion.

4. Light is alſo emitted by attrition and percuſſion. In the experiments which were made by Mr Wedgwood, on the attrition of bodies, he found that different coloured rays were emitted; ſometimes it was a pure white light, as from the diamond; ſometimes of a faint red, as from blackiſh gun flint; and ſometimes of a deep red, as from unglazed white biſcuit earthen ware. But this effect produced by attrition, may perhaps be conſidered as the ſame with that of percuſſion. It is a familiar circumſtance, that ſparks of light are emitted, when two hard bodies, as for inſtance, two quartz ſtones, are ſmartly ſtruck againſt each other; and it appears that light is emitted, or ſparks given out, when theſe bodies are treated by percuſſion or attrition, even under water; and they ſeem equally luminous in atmoſpheric air, oxygen gas, carbonic acid, or hydrogen gaſes. The emiſſion of this light is accompanied with a peculiar ſmell, which varies in different bodies. The ſmell appears to be ſtrongeſt where the friction is greateſt; it has no dependence on the light produced by attrition, becauſe it is often very ſtrong when no light is emitted. Rock cryſtal, quartz, and other hard bodies, alſo emit this ſmell under water †.

When flint and ſteel are ſtruck ſmartly together, a ſpark is produced which will communicate fire to combuſtible ſubſtances. This ſpark has been found to be a particle of the iron which is driven off, and which catches fire as it paſſes through the air. It is to be conſidered as a caſe of combuſtion, and quite different from what happens when two ſtones are rubbed or ſtruck againſt each other.

The matter driven off, when ſtones of quartz are ſtruck againſt each other, conſiſts of ſmall, black, friable bodies, which leave a black ſtain when rubbed on paper, and when examined with a magnifying glaſs, have the appearance of being fuſed. The light is produced in theſe caſes, by the ſubſtances ſtruck together having been red hot. Some have ſuppoſed that they are a combination with oxygen; while others, who have probably examined them more accurately, aſſert that they are pieces of the quartz ſurrounded with a quantity of black powder; and having been raiſed to a very high temperature, ſet fire, in their paſſage through the air, to the combuſtible bodies that are floating in it.

CHAP. III. OF CALORIC.

159 Term explained.

THE word *heat* in common language has two different meanings. When we ſay that we feel heat, it muſt mean the ſenſation of heat excited in the body; but when we ſay that the fire or a ſtone is hot, it means that the power of exciting the ſenſation of heat in us, exiſts in the ſtone or fire. The one is the cauſe, and the other is to be conſidered as the effect. The heat of the ſtone or fire is therefore the cauſe of the ſenſation of heat in the body. Thus the word *heat* is generally employed to expreſs both the ſenſation, and the cauſe of that ſenſation. To prevent any ambiguity in the uſe of theſe terms, the word *caloric* has been adopted in the new chemical nomenclature, to ſignify that ſtate or condition of matter by which it excites in us the ſenſation of heat; and in this ſenſe it is now to be employed.

The nature and effects of caloric or heat are highly intereſting, as curious ſubjects of ſpeculation; but the knowledge of them is of the utmoſt importance in the ſtudy of chemical phenomena, becauſe no change takes place, no decompoſition is effected, and no new compound is formed, without the agency of caloric.

SECT. I. *Of the Nature and Properties of* CALORIC.

160 Two opinions.

Two opinions have been maintained by philoſophers concerning the nature of caloric. According to one, it is ſuppoſed to be a peculiar ſubtile fluid, of a highly elaſtic and penetrating nature, which is univerſally diffuſed. According to the other opinion, it depends on a peculiar tremor or vibration which exiſts among the particles of heated bodies.

161 Bacon's.

162 That heat is motion.

Among the firſt who ſeem to have adopted the latter opinion, was the celebrated Bacon. In his treatiſe, *De forma calidi*, which he propoſed as a model of ſcientific inveſtigation, he enumerates all the facts which were then known concerning heat; and after a cautious conſideration of theſe facts, he concludes, that heat is motion. The facts on which he founded this opinion, were derived from ſome of the moſt familiar methods by which heat is produced in bodies. A blackſmith can make a rod of iron red hot by ſtriking it ſmartly with a hammer; the heavy parts of machinery, by friction upon each other, and the axles of the wheels of carriages, when heavily loaded, ſometimes take fire. A fire may be kindled by the friction of two pieces of dry wood, and the branches of trees ſtrongly rubbed againſt each other by the violence of a ſtorm, have ſet fire to thick foreſts. From the obſervation and conſideration of theſe facts, this eminent philoſopher was led to conclude, that heat is the effect of mechanical impulſe. Since the time of Bacon, this theory has had many followers, and even at the preſent day it is maintained by ſome philoſophers.

163 Diſtinct ſubſtance.

But the theory which ſuppoſes caloric or heat to be a diſtinct material ſubſtance, is now more generally adopted. It was firſt ſuppoſed by thoſe who favoured this theory, that this peculiar matter was chiefly characterized by the great elaſticity, or repulſive power, of the particles among each other; but beſides this property, Dr Cleghorn ſuppoſed that it poſſeſſed another, namely, that while its particles have a ſtrong repulſion for one another, they are attracted by other kinds 164 Is attracted. of matter, with different degrees of force. But whatever opinion may be formed of the nature of caloric, after we have inveſtigated its properties and effects, we ſhall probably find, that the phenomena which it exhibits will be eaſier underſtood, and more ſatisfactorily accounted for, on the ſuppoſition that it is a diſtinct ſubſtance.

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* *Phil. Tranſ.* vol. lxxxii. p. 271.

† *Ibid.* p. 42.

165 Velocity. 1. The rays of light and caloric accompany each other as they proceed from the ſun, or from burning bodies. It is therefore ſuppoſed that they move with the ſame degree of velocity; and if this be the caſe, the velocity of the rays of caloric muſt be equal to 200,000 miles in a ſecond. An experiment made by Mr Pictet proves the great velocity of the rays of caloric. Two concave mirrors, the one of tin, and the other of gilt plaſter, 18 inches in diameter, were placed at the diſtance of 69 feet from each other. A thermometer was placed in the focus of the latter, and a heated bullet of iron in the former. When the bullet was placed in the focus, a thick ſcreen, which was a few inches from the face of the metallic mirror, was removed. The thermometer inſtantly roſe, ſo that the time which caloric requires to move through the ſpace of 69 feet, cannot be eſtimated. And indeed, if caloric, as is moſt probable, moves with the velocity of light, the time that it paſſes the diſtance of 69 feet, or even 69,000 feet, is by far too minute to be meaſured by our inſtruments; ſo that no concluſion whatever with regard to the meaſurement of its velocity, can be drawn from this experiment.

166 Minute particles. 2. From the extreme velocity of caloric, and from its being equal to that of light, it is concluded that its particles are equally minute. From the accumulation of caloric in bodies, and particularly from one ſtriking effect which this accumulation produces, namely, expanſion, it was natural to ſuppoſe that bodies having received this addition, acquired an increaſe of weight. Experiments have therefore been made to aſcertain this effect. Boerhaave weighed a maſs of iron of 5lb. weight, while it was red hot, and afterwards repeated the ſame experiment with other metals, but found no variation, either in the hot or cold bodies, but what he could account for from the errors of the balance. 167 Experiments to aſcertain the weight of caloric, Muſchenbroeck ſuppoſed that heat is ponderous, or produced by a ponderous ſubſtance; and Buffon thought he had proved, by his own experiments, that a body is heavier when it is hot than when it is cold; but when ſimilar experiments were repeated, particularly by Dr Roebuck and Mr Whitchurſt, with very nice and delicate balances, the bodies which were weighed appeared heavier cold, than when they were hot. This ſeems to be owing to the rarefaction of the air ſurrounding that ſcale in which the heated body is placed; the preſſure of which is therefore leſs than that of the air over the other ſcale. From more recent experiments, and particularly one made by Dr Fordyce, it appears that bodies become heavier, but in a very ſmall degree only, not by the increaſe, but by the diminution of temperature. When the whole quantity of 1700 grs. of water was frozen, it was found to be, when carefully weighed, $\frac{3}{10}$ths of a grain heavier than it had been when fluid. At this time the thermometer applied to the veſſel which contained the frozen water, ſtood at 10°; but when it was allowed to remain till the thermometer roſe to 32°, it weighed only $\frac{2}{10}$ths of a grain more than when fluid, and at the ſame temperature. 168 unſucceſsful. But other experiments prove, that the addition of caloric to bodies produces no ſenſible change on their weight. This ſeems to be placed beyond a doubt by the accurate experiments of Lavoiſier, which were made with a view of aſcertaining whether the weight of bodies is altered by heating or cooling them; but he found no difference.

In the year 1787, Count Rumford repeated the experiment of Dr Fordyce with the greateſt care; and varying it in every poſſible way to avoid error, the reſults led him to conclude, that there is no ſenſible difference in the weight of bodies, either by the addition or abſtraction of caloric.

169 Repulſion. 3. Caloric agrees with light in another of its peculiar properties; this is its *repulſive* power, or that tendency of its particles to ſeparate from each other. The particles of caloric, therefore, can never be ſuppoſed to cohere.

170 Reflection. 4. As the rays of light are reflected by poliſhed ſurfaces, ſo it is found that the rays of caloric have the ſame property. The Swediſh chemiſt Scheele diſcovered, that the angle of reflection of the rays of caloric is equal to the angle of incidence. This has been more fully eſtabliſhed by Dr Herſchel. Some very intereſting experiments were made by Profeſſor Pictet of Geneva, which proved the ſame thing. Theſe experiments were conducted in the following manner. Two concave mirrors of tin, of nine inches focus, were placed at the diſtance of twelve feet two inches from each other. In the focus of the one was placed the bulb of a thermometer, and in that of the other a ball of iron two inches in diameter, which was juſt heated ſo as not to be viſible in the dark. In the ſpace of ſix minutes the thermometer roſe 22°. A ſimilar effect was produced by ſubſtituting a lighted candle in place of the ball of iron. Suppoſing that both the light and heat acted in the laſt experiment, he interpoſed between the two mirrors a plate of glaſs, with the view of ſeparating the rays of light from thoſe of caloric. The rays of caloric were thus interrupted by the plate of glaſs, but the rays of light were not perceptibly diminiſhed. In nine minutes the thermometer ſunk 14°; and in ſeven minutes after the glaſs was removed, it roſe about 12°. He therefore juſtly concluded, that the caloric reflected by the mirror, was the cauſe of the riſe of the thermometer. He made another experiment, ſubſtituting boiling water in a glaſs veſſel in place of the iron ball; and when the apparatus was adjuſted, and a ſcreen of ſilk which had been placed between the two mirrors removed, the thermometer roſe 3°; namely, from 47° to 50°.

The experiments were varied by removing the tin mirrors to the diſtance of 90 inches from each other. The glaſs veſſel, with boiling water, was placed in one focus, and a ſenſible thermometer in the other. In the middle ſpace between the mirrors, there was ſuſpended a common glaſs mirror, ſo that either ſide could be turned towards the glaſs veſſel. When the poliſhed ſide of this mirror was turned towards the glaſs veſſel, the thermometer roſe only $\frac{5}{10}$ths of a degree; but when the other ſide, which was darkened, was turned towards the glaſs veſſel, the thermometer roſe 3°.5. And in another experiment performed in the ſame way, the thermometer roſe 3° when the poliſhed ſide of the mirror was turned to the glaſs veſſel, and 9° when the other ſide was turned. Theſe experiments ſhew clearly, that the rays of caloric are reflected from poliſhed ſurfaces, as well as the rays of light.

171 Refraction

5. Tranſparent bodies have the power of refracting the rays of caloric, as well as thoſe of light. They differ alſo in their refrangibility. So far as experiment goes, the moſt of the rays of caloric are leſs refrangible than the red rays of light. The experiments of Dr Herſchel ſhew, that the rays of caloric, from hot or burning bodies, as hot iron, hot water, fires and candles, are refrangible, as well as the rays of caloric which are emitted by the ſun. Whether all tranſparent bodies have the power of tranſmitting theſe rays, or what is the difference in the refractive power of theſe bodies, is not yet known.

172 Three ſets of rays,

6. The light which proceeds from the ſun ſeems to be compoſed of three diſtinct ſubſtances. Scheele diſcovered, that a glaſs mirror held before the fire, reflected the rays of light, but not the rays of caloric; but when a metallic mirror was placed in the ſame ſituation, both heat and light were reflected. The mirror of glaſs became hot in a ſhort time, but no change of temperature took place on the metallic mirror. This experiment ſhews that the glaſs mirror abſorbed the rays of caloric, and reflected thoſe of light; while the metallic mirror, ſuffering no change of temperature, reflected both. 173 coloured and heating. And if a plate of glaſs be held before a burning body, the rays of light are not ſenſibly interrupted, but the rays of caloric are intercepted; for no ſenſible heat is obſerved on the oppoſite ſide of the glaſs; but when the glaſs has reached a proper degree of temperature, the rays of caloric are tranſmitted with the ſame facility as thoſe of light. And thus the rays of light and caloric may be ſeparated.

174 Inviſible have the greateſt heating power.

But the curious experiments of Dr Herſchel have clearly proved, that the inviſible rays which are emitted by the ſun, have the greateſt heating power. In theſe experiments, the different coloured rays were thrown on the bulb of a very delicate thermometer, and their heating power was obſerved. The heating power of the violet, green, and red rays, was found to be to each other as the following numbers:

Violet,	16.
Green,	22.4
Red,	55.

The heating power of the moſt refrangible rays was leaſt, and this power increaſes as the refrangibility diminiſhes. The red ray, therefore, has the greateſt heating power, and the violet, which is the moſt refrangible, the leaſt. The illuminating power, it has been already obſerved, is greateſt in the middle of the ſpectrum, and it diminiſhes towards both extremities; but the heating power, which is leaſt at the violet end, increaſes from that to the red extremity: and when the thermometer was placed beyond the limit of the red ray, it roſe ſtill higher than in the red ray, which has the greateſt heating power in the ſpectrum. The heating power of theſe inviſible rays was greateſt at the diſtance of $\frac{1}{2}$ inch beyond the red ray, but it was ſenſible at the diſtance of $1\frac{1}{2}$ inch.

Dr Herſchel's experiments have been varied, and ſtill farther confirmed by a ſet of experiments by Sir H. Englefield, the reſults of which were the following:

Therm. in the blue ray roſe	in 3′	from 55° to 56°
in the green	in 3′	from 54° to 58°
in the yellow	in 3′	from 56° to 62°
in the full red	in $2\frac{1}{2}$′	from 56° to 72°
in confines of the red	in $2\frac{1}{2}$′	from 58° to $73\frac{1}{2}$°
quite out of viſible light	in $2\frac{1}{2}$′	from 61° to 79°

The thermometer uſed in theſe experiments had its bulb blackened with Indian ink.

In the following experiments, three thermometers were employed; one had a naked ball, one was whitened, and the other was blackened. They were expoſed to the ſun's rays till they became ſtationary, when the thermometer with the

Naked ball ſtood at	$58\frac{1}{2}$°
Whitened ball	$58\frac{1}{2}$°
Blackened ball	63°

In the full-red ray	the blackened thermom. roſe	in 3′ from 58° to 61°
	whitened -	in 3′ from 55° to 58°
In quite dark -	blackened thermom.	in 3′ from 59° to 64°
	whitened -	in 3′ from 58° to $58\frac{1}{2}$°
In confines of the red	black thermom. -	in 3′ from 59° to 71°
	white - -	in 3′ from $57\frac{1}{2}$° to $60\frac{1}{2}$°

In other experiments which were made afterwards, the reſults were,

In the full-red ray	the black thermom. roſe	in 3′ from 66° to 82°
	white -	in 3′ from 66° to $69\frac{1}{2}$°
In quite dark $\frac{1}{2}$ inch out of the red, the black thermom. roſe -	- - -	in 3′ from 70° to 84°

In this laſt experiment, when the thermometer was carried into the faint-red light, it ſunk quickly; and roſe again as quickly, when carried into the dark focus: but when carried into the dark on the other ſide of the red light, it ſunk very rapidly, and did not appear to receive any heat at all †.

Thus it appears, that the rays of caloric and the rays of light are different: for theſe experiments clearly ſhow, that there are rays which produce heat, but give no light, and rays which give light, but produce no heat. It was formerly mentioned, that there is another ſet of rays which give neither light nor heat, but whoſe exiſtence has been fully demonſtrated by the remarkable effect which they produce in reducing the metallic ſalts and oxides. The light which is emitted from the ſun then conſiſts of three diſtinct ſets of rays which have been fully recognized by their different degrees of refrangibility and their different effects. The heating rays are in the ſmalleſt degree refrangible; the rays which have the greateſt effect on the metallic oxides are the moſt refrangible, and the coloured rays are in an intermediate degree. The inviſible rays beyond the red extremity of the ſpectrum, which are leaſt refracted, have the greateſt heating power; the inviſible rays beyond the violet end, which are moſt refracted, have the greateſt power in reducing the metallic ſalts or oxides, and the rays in the middle of the ſpectrum have the greateſt illuminating power.

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† *Jour. Roy. Inſt.* vol. i. p. 200.

SECT. II. *Of the* EFFECTS *of* CALORIC.

175 Effects of caloric different in different bodies.

The effects of ſo powerful an agent as heat muſt be very conſiderable, and theſe effects are found to be different in different bodies, or as it is more or leſs accumulated in theſe bodies. One general effect is, that the accumulation of heat enlarges, and its abſtraction proportionally diminiſhes, the bulk of all bodies. When this accumulation is continued in ſome bodies, they change their condition from the ſtate of ſolid to that of liquid; and, when the accumulation is ſtill greater, liquid bodies are reduced to the form of vapour. Theſe effects, certainly curious and intereſting of themſelves, are of the utmoſt importance in the phenomena of nature and in the proceſſes of art; and the knowledge of the laws which have been deduced from theſe remarkable changes, enables us to explain many natural appearances, and to improve many of the arts of life.

1. Of EXPANSION.

176 Caloric expands all bodies.

1. One of the moſt general effects of heat, it has been obſerved, is the expanſion of bodies; that is, when caloric is accumulated in any body, it is enlarged in bulk; and, when that quantity of caloric is abſtracted, there is a correſponding contraction. Experience teaches us, that this effect of caloric is invariable and uniform in all the ſimpler kinds of matter. In ſome bodies, however, there are ſeeming exceptions to this general rule. In theſe bodies, when the temperature riſes a little above, or falls a little below a certain point, they are ſubject to irregular variations of their bulk; but theſe irregularities are limited to a few bodies, and to certain ſtates of temperature of theſe bodies; for when they are expoſed to equal variations of heat, above or below the temperature at which theſe irregularities are obſerved, the general law of expanſion uniformly holds. The expanſion of all bodies by heat, therefore, and their correſponding contraction by the abſtraction of caloric or by cold, may be conſidered as one of the moſt general facts in chemical ſcience.

177 Exceptions.

178 Expanſion proved.

2. There are many familiar inſtances of the expanſion of bodies by means of caloric, and this can be proved by very ſimple experiments. We ſhall mention an example of this effect on bodies in the ſolid, the liquid, and the gaſeous ſtate.

179 In a ſolid body.

(1.) If a rod of metal, as of iron, of an inch in diameter, and ſix or eight inches long, and the ſame thickneſs through its whole length, be exactly fitted to paſs through a hole in a plate of the ſame metal, and to be admitted lengthwiſe within the projecting edges of a ruler while it is cold; the ſame rod, when it is made red hot, will be found to have enlarged in bulk ſo much, that it will not fall between the projecting parts of the ruler, nor will it paſs through the hole; but when it is cooled, or reduced to its former temperature, it again contracts, and returns preciſely to its former dimenſions.

180 In a liquid.

(2.) As an example of a liquid, whoſe bulk is enlarged by the accumulation of caloric, fill the body of a glaſs veſſel which has a long ſlender neck with ſpirit of wine. On the application of heat the liquid in the body of the veſſel is expanded, and riſes in the neck; and when the heat is abſtracted, and the liquid returns to its former temperature, it is again contracted, and returns to its former bulk. This experiment is moſt conveniently performed by immerſing the body of the veſſel in hot water.

181 In an elaſtic fluid.

(3.) The expanſion of a body in the gaſeous ſtate by the accumulation of caloric, is ſhewn by the following experiment. Let a quantity of air be confined in a bladder, but not in ſuch quantity as that the bladder ſhall be fully diſtended with it. If the bladder is expoſed to heat, the confined air expands, and the bladder is fully diſtended; but when it is again cooled, the air reſumes its former bulk, and the bladder its original flaccid ſtate.

182 Uniform in the ſame bodies.

3. Thus it appears, that all bodies expand by heat, and contract by cold, and the quantity of this expanſion is uniformly the ſame in the ſame bodies, when expoſed to the ſame temperature. But this quantity is found to differ greatly in different kinds of matter, by the ſame increaſe or diminution of their heat. In ſolid bodies it is leaſt, in liquids it is greater, but in elaſtic fluids greateſt of all; and in different kinds of ſolids, liquids, and elaſtic fluids, this difference is very conſiderable. The ratio at which this expanſion takes place in different bodies, can only be aſcertained by experiment; and as the knowledge of this is a matter of great conſequence in many of the arts, experiments have been made with this view by different philoſophers (L).

183 But very different in ſolids, liquids, and elaſtic fluids.

The expanſion of gaſeous bodies, we have ſaid, is greateſt, that of liquids leſs, and that of ſolids leaſt of all, by being expoſed to the ſame degree of heat, which will appear from the following proportions.

100 cubic inches of	Atmoſpheric air,	from 32° to 112° increaſed to	137.5 cubic inches.
	Water,		104.5
	Iron,		100.1

(L) See experiments on this ſubject by Mr Elliot, Phil. Tranſ. vol. xxxix. and by Mr Smeaton, ibid. vol. xlviii.

184
Effects of expanſion on brittle ſubſtances.

4. This expanſive effect of heat will enable us to account for the cracking or breaking of veſſels which are made of brittle ſubſtances, by its ſudden application or abſtraction. This is particularly the caſe with thoſe ſubſtances which have little flexibility, as caſt iron, glaſs, or earthen ware; and accidents of this kind moſt frequently happen in veſſels made of theſe materials. If, for inſtance, heat be ſuddenly applied to a glaſs veſſel of conſiderable thickneſs, its external ſurface to which it is firſt applied expands more than the internal parts; the conſequence muſt therefore be, that they are ſeparated or drawn aſunder, and the veſſel is ſplit or broken.

185
In fitting iron hoops to carriage wheels.

5. One of the beſt illuſtrations of this expanſion by heat and contraction by cold on ſolid bodies, is in the application of iron hoops to carriage wheels. The hoop which has been intended for the wheel is made of rather ſmaller dimenſions than exactly to fit it. It is then made red hot, and while it is thus expanded, it is applied to the wheel. It is ſuddenly cooled by throwing cold water upon it, when it contracts, and returning to its former dimenſions, is ſtrongly faſtened on the wheel.

186
Different metals unequally affected.

The unequal contraction at the ſame degree of temperature, which is obſerved among ſolids, liquids, and aeriform ſubſtances, alſo takes place among ſolids themſelves. Thus, different metallic ſubſtances, at the ſame temperature, are found to expand and contract very unequally.

187
Uſe of this in conſtructing the pendulum.

6. Advantage has been taken of this unequal contraction of metallic ſubſtances, to remedy thoſe defects and imperfections of delicate inſtruments, which are occaſioned by the contraction and expanſion of the ſubſtances employed in their conſtruction, when expoſed to different temperatures. Theſe inconveniences were moſt felt in inſtruments which were employed for the meaſurement of time, where great accuracy was required. The ſpring of a watch and the pendulum of a clock being ſubject to the ſame law of contraction and expanſion by heat and cold, in theſe changes, neceſſarily cauſed variations, in proportion to the extent of the effect. But as different metals were obſerved to expand unequally by the ſame temperature, this was applied to the conſtruction of thoſe parts of the inſtrument on which the accuracy of its indications depends. The equable meaſurement of time, for inſtance, by a clock, depends on the length of the pendulum always continuing the ſame. If it is ſubject to variations in length by expanſion or contraction, there will alſo be variations in the rate of its motions; for when the pendulum is lengthened by heat, the clock goes ſlower; and when it is ſhortened by cold, it goes faſter. It becomes therefore an object of great importance, that theſe inſtruments ſhould go at an equable rate in all temperatures; but this can only be effected by having the pendulum ſo conſtructed, that it ſhall neither lengthen by heat, nor contract by cold. This is done by conſtructing a pendulum in the following manner.

"From the point of expanſion A (fig. 1. Plate CXLII.) a rod or thick wire, AB, of the leſs expanſible metal, muſt hang down a certain length. At the lower end it muſt have a ſtud, or croſs piece, BC, ſtrongly faſtened, and projecting a little to one ſide. On the projecting part, C, of this croſs piece, muſt be erected a pillar, CD, of the more expanſive metal. To the top of this pillar, another croſs and projecting piece, DE, muſt be ſtrongly faſtened; and, from this laſt, muſt again hang down another rod or wire, EF, of the firſt metal, having the ball of the pendulum at its extremity. And now, if the height of the pillar CD be one-third of the length of the two rods taken together, the pendulum can neither be lengthened by heat nor ſhortened by cold. For by the expanſion of the pillar, the pendulum is ſhortened, or the ball is raiſed nearer to the point of ſuſpenſion, becauſe the upper end D of the pillar is more raiſed by its expanſion, than the lower end C is depreſſed by the expanſion of AB; and, on the other hand, by its contraction, the pendulum is lengthened, or the ball is lowered: but, while this happens, the two rods, by their expanſion or contraction, produce a contrary effect; and the quantity of expanſion or contraction is the ſame in the rods that it is in the pillar, the greater length in the rods compenſating for the greater expanſibility of the pillar. The conſequence therefore muſt be, that the length of the pendulum, that is, the diſtance between the point of ſuſpenſion and the ball, cannot be varied by heat or cold. Accordingly, the clocks made for the uſe of aſtronomers, have pendulums conſtructed upon this principle, in which pillars of the more expanſible metals are employed to counteract the expanſion of the other parts of the pendulum-rod."

188
The bulk of water when frozen is increaſed,

189
and acts with prodigious force.

7. There are, however, ſome remarkable inſtances which are ſeeming exceptions to this general law of expanſion. This is the caſe with thoſe bodies which paſs from the liquid to the ſolid ſtate; as for inſtance, water, when it aſſumes the ſolid form. Cloſe veſſels which are filled with water, are burſt when it freezes. In an experiment made by Mr Boyle, a braſs tube three inches in diameter, which was cloſed with a moveable ſtopper, was filled with water; when the water was frozen, it raiſed a weight equal to 74 lb. with which the ſtopper was loaded. In an experiment by the Florentine academicians, a hollow braſs globe, the diameter of whoſe cavity was an inch, was burſt by freezing the water with which it was filled. Muſchenbroeck has computed the force neceſſary to produce this effect, by eſtimating it equal to a preſſure of 27,720 lbs. weight. But the moſt remarkable experiments to prove the expanſive force of ice, were made by Major Williams in Canada, in the years 1784 and 1785. The iron plugs with which iron bombſhells filled with water were cloſed up by driving them in ſtrongly with a hammer, were thrown out to a great diſtance by the force of the congelation of the water; and when the plugs were ſo firmly ſecured as to reſiſt this force, the ſhell itſelf was burſt *.

190
Other effects.

8. To the ſame expanſive force in the congelation of water, the burſting of water-pipes, the ſplitting of trees and of rocks, is to be aſcribed, which not unfrequently happens when the water which has been collected in their cavities or fiſſures, is frozen. The ſtones of the pavement are alſo raiſed and looſened by the freezing of the water in the earth in which they are imbedded, which is thus increaſed in bulk, and exerts its expanſive force.

9. Attempts have been made to diſcover the cauſe of this aſtoniſhing effect. According to ſome, it is owing

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* *Edin. Tranſ.* vol. ii. p. 23.

191
Accounted for

owing to the extrication of the air which water holds in combination in a denſe, nonelaſtic ſtate. When the water is freezing, part of the air aſſumes the elaſtic form, and ſeparates from it; but when the ſurface of the water is covered with ice, no more air can make its eſcape. It is then confined, and forms thoſe numerous cavities which are obſerved in ice. In conſequence of theſe cavities, a maſs of ice muſt be of greater bulk than the water previous to congelation, and cannot therefore be contained in the ſame ſpace: But another cauſe, which is perhaps the moſt probable, has been aſſigned for this increaſe of bulk, and conſequent expanſive force.

192
from the new arrangement of the particles.

Liquids which on cooling become ſolid, and aſſume a regular form, are always found to increaſe in bulk. Water, when it paſſes from the liquid to the ſolid ſtate, has a ſtrong tendency among its parts to arrange themſelves in a determinate manner. They aſſume the form of priſmatic cryſtals, which croſs each other at angles of 60° and 120°. In this way the increaſe of bulk, and the expanſive force of water when it is conſolidated, are accounted for.

193
In caſt iron

10. Some metallic ſubſtances, particularly caſt-iron, are obſerved to enlarge in bulk, when they paſs from the fluid to the ſolid ſtate, in the ſame way as water. To this increaſe of bulk in caſt-iron when it cools, are owing the ſharpneſs and diſtinctneſs of the lines in the ornamental figures on grates and furnaces which are made of this metal. The metal is introduced into the mould while it is fluid, or in a ſtate of fuſion, and increaſing in bulk as it cools, the minute cavities of the mould are more accurately filled. This increaſe of bulk, as in the caſe of water when it becomes ſolid, is alſo aſcribed to a determinate arrangement of the parts of the metal, or to cryſtallization.

194
The thermometer invented.

11. On the expanſive property of bodies depends the conſtruction of the thermometer, which is employed for the meaſurement of the relative temperatures of bodies. The invention of this inſtrument is generally aſcribed to Sanctorio, an Italian phyſician, who lived about the beginning of the 17th century, although it is ſaid by ſome, that thermometers were made by Drebel, a Dutch phyſician, and that they were common in Holland, and even in England, before Sanctorio was known in theſe countries.

195
Firſt conſtruction.

In the thermometer of Sanctorio, the expanſive power of air was employed to meaſure the temperature. His thermometer is conſtructed in the following manner. A tube of glaſs of 18 inches or two feet in length, open at one end, is blown into a ball at the other. When the ball is heated, the air within is expanded, and while the air is thus expanded, if the open end of the tube be immerſed in a veſſel filled with any coloured fluid; as the internal air cools, and is diminiſhed in bulk, the liquid will riſe in the tube by the preſſure of the external air on the ſurface of the liquid in the veſſel. A ſcale of equal degrees was then applied to the whole length of the tube, and the thermometer was conſtructed. To aſcertain the heat of any body, as for inſtance the hand, it was applied to the ball, and if this temperature was greater than the medium in which the apparatus was placed, the internal air was rarefied, and conſequently depreſſed the ſurface of the coloured liquid in the tube. The number of degrees of this depreſſion was obſerved and compared in different experiments,

196
Imperfect.

As for inſtance, the difference of temperature of the body at different periods, to aſcertain which, it is ſaid, it was employed by the inventor. But the inaccuracy of this inſtrument will be obvious; when we conſider that it depended, not only on the preſſure, but alſo on the temperature of the atmoſphere.

197
Improved.

This defect in the air thermometer was remedied by Mr Boyle, and by the Florentine academicians, nearly at the ſame time; and they thought of employing other fluids. The firſt that was uſed was ſpirit of wine, which contracting and expanding more than water at the ſame temperature, and not being liable to be frozen by cold, was found to be much more convenient. Quickſilver was ſome time afterwards employed in the ſame way. The ball of the glaſs, and part of the tube, was filled with the fluid, when the open extremity of the tube was cloſed. When heat was applied to the ball, the fluid within expanded, and contracted by cold, without being influenced by the preſſure of the atmoſphere, as in Sanctorio's thermometer. But ſtill this thermometer was very imperfect, for want of determinate points in the ſcale, by which different thermometers might be compared together. This was firſt pointed out by Sir Iſaac Newton, and after various improvements, it was brought to its preſent ſtate of perfection.

198
Fahrenheit's thermometer.

The method of conſtructing Fahrenheit's thermometer, which is now in general uſe in this country, is the following: A ſmall ball is blown on the end of a glaſs tube, of a uniform width throughout. The ball and part of the tube are then to be filled with quickſilver which has been previouſly boiled to expel the air. The open end of the tube is then to be hermetically ſealed (M). The next object is to conſtruct the ſcale. It is found by experiment, that melting ſnow or freezing water is always at the ſame temperature. If, therefore, a thermometer be immerſed in the one or the other, the quickſilver will always ſtand at the ſame point. It has been obſerved, too, that water boils under the ſame preſſure of the atmoſphere at the ſame temperature. A thermometer, therefore, immerſed in boiling water, will uniformly ſtand at the ſame point. Here then are two fixed points from which a ſcale may be conſtructed, by dividing the intermediate ſpace into equal parts, and carrying the ſame diviſions as far above and below the two fixed points as may be wanted. Thus, thermometers conſtructed in this way may be compared together; for if they are accurately made, and placed in the ſame temperature, they will always point to the ſame degree on the ſcale.

The fluid that is now generally employed is quickſilver, and it is found to anſwer beſt, becauſe its expanſions are moſt equable. The freezing point of Fahrenheit's thermometer is marked 32°, and the reaſon of this is ſaid to have been, that this artiſt thought

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(M) This is done by heating the end of the tube with the flame of a lamp, and by cloſing it while the glaſs is ſoftened.

thought that he had produced the greateſt degree of cold by a mixture of ſnow and ſalt; and the point at which the thermometer then ſtood in this temperature, was marked zero. The boiling point in this thermometer is 212°, and the intermediate ſpace between the boiling and freezing points is therefore divided into 180°. This is the thermometer that is commonly uſed in Britain.

There are three other thermometers employed in different countries of Europe, which differ from each other in the number of degrees between the freezing and boiling points.

199 Reaumur's. Reaumur's thermometer was generally uſed in France before the revolution, and is ſtill employed in different countries on the continent. The freezing point in this thermometer is marked zero, and the boiling point 80°. To convert the degrees of Reaumur's thermometer to thoſe of Fahrenheit, the following is the formula. Reaum. $\frac{\times 9}{4} + 32 =$ Fahr. that is multiply the degrees of Reaumur by 9, divide by 4, and add 32. This gives the correſponding degrees on Fahrenheit's ſcale.

200 Celſius. The thermometer of Celſius has the ſpace between the freezing and boiling points divided into 100°. The boiling point is 100°, and the freezing point zero. This thermometer is uſed in Sweden. The *thermometre centigrade*, now uſed in France, has the ſcale divided in the ſame way. To convert the degrees of this thermometer into thoſe of Fahrenheit; Cel. $\frac{\times 9}{5} + 32 =$ Fahr.

201 Deliſle's. In Deliſle's thermometer, which is uſed in Ruſſia, the ſpace between the boiling and freezing points is divided into 150°; but the degrees are reckoned downwards. The boiling point is marked zero, and the freezing point 150°. To reduce the degrees of this thermometer under the boiling point to thoſe of Fahrenheit. Del. $\frac{\times 6}{5} - 212 =$ Fahr. and above the boiling point. Del. $\frac{\times 6}{5} + 212 =$ Fahr.

Such then are the principles and mode of conſtruction of the thermometer; an inſtrument which has been of the utmoſt importance in enabling us to diſcover many of the properties and effects of caloric, as by it only we can aſcertain with accuracy the relative temperatures (N).

201 Quantity of expanſion. 12. It has been an object of conſiderable intereſt and importance to aſcertain the quantity and rate of expanſion in bodies. Among ſolid bodies the quantity of expanſion is very ſmall, ſo that a nice apparatus is neceſſary to aſcertain it. But it appears that the ratio of this expanſion is equable, or nearly ſo. The reſults of experiments made by Mr Smeaton and ſome other philoſophers upon this ſubject, will be ſeen in the following table.

201 Of different metals.

Temperature.	Platina.	Antimony.	Steel	Iron.	Caſt Iron	Biſmuth.	Copper.	Caſt Braſs.	Braſs Wire
32°	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
212	120,104	120,130	120,147	120,151		120,167	120,204	120,000	120,232
White heat			123,428	121,500	122,571				

Temperature.	Tin.	Lead.	Zinc.	Hammered Zinc.	Zinc 8. Tin 1.	Lead 2. Tin 1.	Braſs 2. Zinc 1.	Pewter.	Copper 3. Tin 1.
32°	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
212	120,298	120,344	120,355	120,373	120,123	120,301	120,247	120,274	120,218

204 Of glaſs. The rate of the expanſion of glaſs, which is a matter of conſiderable importance, has been aſcertained by M. de Luc, and is exhibited in the following table:

Temperature.	
32°	100,000
50	100,006
70	100,014
100	100,023
120	100,033
150	100,044
167	100,056
190	100,069
212	100,083

205 Of liquids. 13. The expanſion of liquid bodies is greater than that of ſolids, but it is not equable with equal additions of temperature. It has been obſerved, that thoſe liquids which are moſt readily brought to the ſtate of vapour, or whoſe boiling point is loweſt, expand moſt. With the ſame given temperature, the expanſion of water is greater than that of mercury, and the expanſion of alcohol is greater than that of water. The boiling point of water is lower than that of mercury, and the boiling point of alcohol is lower than that of water; from which it would appear, that the expanſion of liquids is nearly in the inverſe ratio of their boiling temperatures, and this expanſion ſeems to increaſe with the temperature; that is, the nearer a liquid is to that point of temperature at which it boils, the greater is the degree of expanſion by the addition of caloric; and the farther it is from the boiling temperature, the ſmaller is the increaſe of bulk by the addition of caloric. The following table exhibits the ratio of expanſion of ſeveral liquids, as they have been aſcertained by different philoſophers.

(N) For meaſuring high degrees of temperature, the pyrometer of Wedgwood is employed, which will be deſcribed under the earth *alumina*.

Table of the Rate of Expanſion of different Liquids from 32° to 212°.

Temp.	Mercury.	Linſeed Oil.	Sulphuric Acid.	Nitric Acid.	Water.	Oil of Turpent.	Alcohol.
32°	100000	100000	—	—	—	—	100000
40	100081	—	99752	99514	—	—	100539
50	100183	—	100000	100000	100023	100000	101105
60	100304	—	100279	100486	100091	100460	101688
70	100406	—	100558	100990	100197	100993	102281
80	100508	—	100806	101530	100332	101471	102890
90	100610	—	101054	102088	100694	101931	103517
100	100712	102760	101317	102620	100908	102446	104162
110	100813	—	101540	103196	—	102943	—
120	100915	—	101834	103776	101404	103421	—
130	101017	—	102097	104352	—	103954	—
140	101119	—	102320	105132	—	104573	—
150	101220	—	102614	—	102017	—	—
160	101322	—	102893	—	—	—	—
170	101424	—	103116	—	—	—	—
180	101526	—	103339	—	—	—	—
190	101628	—	103587	—	103617	—	—
200	101730	—	103911	—	—	—	—
212	101835	107250	—	—	104577	—	—

206
All gaſes expand equably.

14. It has been proved by experiment that all gaſeous bodies undergo the ſame expanſion, with the ſame addition of heat. This has been aſcertained by the ingenious experiments of Mr Dalton and M. Gay-Luſſac. The increaſe of bulk of ſome elaſtic fluids from 32° to 212°, as determined by the latter, will be ſeen in the following table:

Atmoſpheric air 100 parts, increaſed	37.50	
Hydrogen gas -	37.52	difference +0.2
Oxygen gas -	37.48	—0.02
Azotic gas -	37.49	—0.01 *

In other experiments he found, that the expanſion of the vapour of water and of ether correſponded with the expanſion of other gaſes; and he remarks, that this property of the equable dilatation of the vapour of ether and water, and the gaſes, with the ſame degrees of temperature, depends not on the peculiar nature of the vapours and gaſes, but ſolely on their elaſtic ſtate.

Mr Dalton's experiments ſhew that the expanſion of air is very nearly equable. It appears, however, that the rate of expanſion diminiſhed as the temperature increaſed. The expanſion from 55° to 132½°, which includes 77½°, was 167 parts; but the expanſion from 132½° to 212°, the next 77½° was only 158 parts, which was nine parts leſs than the firſt. The ſame philoſopher obſerves, that the reſults of ſeveral experiments which he made upon hydrogen gas, oxygen gas, carbonic acid gas, and nitrous gas, correſpond with thoſe on atmoſpherical air, not only in the total expanſion, but in the gradual diminution of it in aſcending. Small differences were obſerved, but they never exceeded ſix or eight parts in the whole amount 325; and differences to this amount, he adds, will take place in common air, when not freed from aqueous vapour, which, he ſays, was the ſituation of his factitious gaſes.

2. Of Fluidity.

207
Change of ſtate.

1. We have now ſeen the effects of caloric in expanding bodies, when it is accumulated in them. When a ſolid body, as a piece of iron, is expoſed to a high temperature, it is enlarged in bulk; and when the additional quantity of caloric with which it had combined is withdrawn, it returns to its former dimenſions; but when ſtill greater additions are made to moſt bodies, it is not merely a change of bulk that takes place, but a total change of their properties.

All matter exiſts, either in the ſtate of ſolid, of liquid, or in the ſtate of vapour. Moſt bodies, by the addition or the abſtraction of caloric, are convertible from one of theſe ſtates into another. Let us take water for an example. Ice is water in the ſolid ſtate. When a maſs of ice has received a proper quantity of caloric, it aſſumes the liquid ſtate; and, when this liquid has received another portion of caloric, it is changed into the ſtate of vapour. But if this vapour is deprived of a certain portion of caloric, it returns to the ſtate of liquid or that of water; and when this water is deprived of another portion of caloric, it becomes ſolid, or is converted into ice.

Thus it appears, that a ſolid body may be converted into a liquid by means of caloric; and that a liquid may be converted into an elaſtic fluid by the ſame means. This ſeems to be a general law, to which there are but few exceptions. Some bodies may be converted into all the three ſtates, as water; others, as ſpirit of wine, exiſt only in the fluid ſtate, and there are ſome ſolid bodies which are not convertible into the ſtate of liquid; but theſe exceptions are ſo few, that it has been ſuppoſed the ſame effect would follow, were theſe bodies expoſed to a proper degree of temperature.

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* *Ann. de Chem.* vol. xliii. p 167.

208 Bodies become fluid at the ſame degree of temperature.

2. The temperature at which theſe changes are effected, is invariably the ſame in the ſame body. Thus, a maſs of ice is converted into the ſtate of liquid or of water, when it is expoſed to a temperature above 32°; and water, when it is raiſed to the temperature of 212°, aſſumes the ſtate of vapour or of ſteam. But although this temperature is conſtant in the ſame bodies, it varies greatly in different bodies. Thus, ſpirit of wine and ether are converted into vapour at a very low temperature, while mercury and the fixed oils, to undergo this change, require a temperature far above that which is neceſſary for the converſion of water.

209 In ſome inſtantaneouſly.

210 In others gradually.

3. Some bodies are inſtantaneouſly converted from the ſolid to the liquid ſtate. Thus ice, when the temperature is raiſed, paſſes immediately from the ſolid to the fluid ſtate. Other bodies undergo a gradual change. They firſt become ſoft, as in the inſtance of melting wax, and paſs through the different degrees of ſoftneſs, till at laſt they become perfectly fluid.

4. It may perhaps now ſeem ſurpriſing, that phenomena which were ſo familiar ſhould have exiſted ſo long without the true explanation of the changes which bodies undergo, in paſſing from the ſolid to the liquid or vaporous ſtate, or from the fluid to the ſolid ſtate. The want of inſtruments to meaſure accurately the relative degrees of temperature at which theſe changes take place, might perhaps be one cauſe of the unſucceſsful inveſtigations of philoſophers on this ſubject. But even after the invention and improvement of the thermometer, it was long before the ſecret, and we may add, ſimple cauſe of theſe wonderful effects, was fully aſcertained. It was reſerved for the ſagacity of Dr Black to give the true explanation. The era of the diſcovery of this law, of ſuch univerſal application to the phenomena of nature, may be regarded as one of the moſt important in the hiſtory of chemical ſcience. Dr Black was always diſtinguiſhed for caution and preciſion in all his views; and as the progreſſive ſteps by which this celebrated philoſopher was led to aſcertain the true cauſe of fluidity afford us a fine example of ſimple and elegant inveſtigation, we ſhall detail the experiments by which it was eſtabliſhed in his own words.

211 Great diſcovery of Dr Black.

5. After ſtating that the cauſe of fluidity which had been formerly given was unſatisfactory, and inconſiſtent with the phenomena, he obſerves that "theſe phenomena, when attentively conſidered, ſhew that fluidity is produced by heat, in a very different manner from that which was commonly imagined; a manner, however which, when underſtood, enables us to explain many particulars relating to heat or cold, which appeared in the former view of the ſubject, quite perplexing and unaccountable.

212 Fluidity ſuppoſed to be owing to a ſmall addition of caloric.

"Fluidity was univerſally conſidered as produced by a ſmall addition to the quantity of heat which a body contains, when it is once heated up to its melting point; and the returning of ſuch body to a ſolid ſtate, as depending on a very ſmall diminution of the quantity of its heat, after it is cooled to the ſame degree; that a ſolid body, when it is changed into a fluid, receives no greater addition to the heat within it than what is meaſured by the elevation of temperature indicated after fuſion by the thermometer; and that, when the melted body is again made to congeal, by a diminution of its heat, it ſuffers no greater loſs of heat than what is indicated alſo by the ſimple application to it of the ſame inſtrument.

213 Inconſiſtent with facts.

"This was the univerſal opinion on this ſubject, ſo far as I know, when I began to read my lectures in the univerſity of Glaſgow, in the year 1757. But I ſoon found reaſon to object to it, as inconſiſtent with many remarkable facts, when attentively conſidered; and I endeavoured to ſhew, that theſe facts are convincing proofs that fluidity is produced by heat in a very different manner.

"I ſhall now deſcribe the manner in which fluidity appeared to me to be produced by heat, and we ſhall then compare the former and my view of the ſubject with the phenomena.

214 Caloric is abſorbed by ſolids becoming fluid.

"The opinion I formed from attentive obſervation of the facts and phenomena, is as follows. When ice, for example, or any other ſolid ſubſtance, is changing into a fluid by heat, I am of opinion that it receives a much greater quantity of heat than what is perceptible in it immediately after by the thermometer. A great quantity of heat enters into it, on this occaſion, without making it apparently warmer, when tried by that inſtrument. This heat, however, muſt be thrown into it, in order to give it the form of a fluid; and I affirm, that this great addition of heat is the principal and moſt immediate cauſe of the fluidity induced.

215 Fluids becoming ſolid give out caloric.

"And, on the other hand, when we deprive ſuch a body of its fluidity again, by a diminution of its heat, a very great quantity of heat comes out of it, while it is aſſuming a ſolid form, the loſs of which heat is not to be perceived by the common manner of uſing the thermometer. The apparent heat of the body, as meaſured by that inſtrument, is not diminiſhed, or not in proportion to the loſs of heat which the body actually gives out on this occaſion; and it appears from a number of facts, that the ſtate of ſolidity cannot be induced without the abſtraction of this great quantity of heat. And this confirms the opinion, that this quantity of heat, abſorbed, and as it were, concealed in the compoſition of fluids, is the moſt neceſſary and immediate cauſe of their fluidity.

"To perceive the foundation of this opinion, and the inconſiſtency of the former with many obvious facts, we muſt conſider, in the firſt place, the appearances obſervable in the melting of ice, and the freezing of water.

216 Proved by the melting of ice and freezing of water.

If we attend to the manner in which ice and ſnow melt, when expoſed to the air of a warm room, or when a thaw ſucceeds to froſt, we can eaſily perceive, that however cold they might be at the firſt, they are ſoon heated up to their melting point, or begin ſoon at their ſurface to be changed into water. And if the common opinion had been well founded, if the complete change of them into water required only the further addition of a very ſmall quantity of heat, the maſs, though of a conſiderable ſize, ought all to be melted in a very few minutes or ſeconds more, the heat continuing inceſſantly to be communicated from the air around. Were this really the caſe, the conſequences of it would be dreadful in many caſes; for, even as things are at preſent, the melting of great quantities of ſnow and ice occaſions violent torrents, and great inundations in the cold countries, or in the rivers that come from them. But, were the ice and ſnow to melt as ſuddenly as they muſt neceſſarily do, were the former opinion of the action of heat in melting them well founded, the torrents and inundations would be incomparably more irreſiſtible and dreadful. They would tear up and ſweep away every thing, and that ſo ſuddenly, that mankind ſhould have great difficulty to eſcape from their ravages. This ſudden liquefaction does not actually happen; the maſſes of ice or ſnow melt with a very ſlow progreſs, and require a long time, eſpecially if they be of a large ſize, ſuch as are the collections of ice, and wreaths of ſnow, formed in ſome places during the winter. Theſe, after they begin to melt, often require many weeks of warm weather, before they are totally diſſolved into water. This remarkable ſlowneſs with which ice is melted, enables us to preſerve it eaſily during the ſummer, in the ſtructures called ice-houſes. It begins to melt in theſe, as ſoon as it is put into them: but, as the building expoſes only a ſmall ſurface to the air, and has a very thick covering of thatch, and the acceſs of the external air to the inſide of it is prevented as much as poſſible, the heat penetrates the ice-houſe with a ſlow progreſs, and this, added to the ſlowneſs with which the ice itſelf is diſpoſed to melt, protracts the total liquefaction of it ſo long, that ſome of it remains to the end of ſummer. In the ſame manner does ſnow continue on many mountains during the whole ſummer, in a melting ſtate, but melting ſo ſlowly, that the whole of that ſeaſon is not a ſufficient time for its complete liquefaction.

217
Melting of ice a very ſlow proceſs.

“ This remarkable ſlowneſs with which ice and ſnow melt, ſtruck me as quite inconſiſtent with the common opinion of the modification of heat, in the liquefaction of bodies.

218
Foundation of the diſcovery.

“ And this very phenomenon is partly the foundation of the opinion I have propoſed; for if we examine what happens, we may perceive that a great quantity of heat enters the melting ice, to form the water into which it is changed, and that the length of time neceſſary for the collection of ſo much heat from the ſurrounding bodies, is the reaſon of the ſlowneſs with which the ice is liquefied. If any perſon entertain doubts of the entrance and abſorption of heat in the melting ice, he needs only to touch it; he will inſtantly feel that it rapidly draws heat from his warm hand. He may alſo examine the bodies that ſurround it, or are in contact with it, all of which he will find deprived by it of a great part of their heat; or if he ſuſpend it by a thread, in the air of a warm room, he may perceive with his hand, or by a thermometer, a ſtream of cold air deſcending conſtantly from the ice; for the air in contact is deprived of a part of its heat, and thereby condenſed and made heavier than the warmer air of the reſt of the room; it therefore falls downwards, and its place round the ice is immediately ſupplied by ſome of the warmer air; but this, in its turn, is ſoon deprived of ſome heat, and prepared to deſcend in like manner; and thus there is a conſtant flow of warm air from around, to the ſides of the ice, and a deſcent of the ſame in a cold ſtate, from the lower part of the maſs, during which operation the ice muſt neceſſarily receive a great quantity of heat.

“ It is, therefore, evident that the melting ice receives heat very faſt, but the only effect of this heat is to change it into water, which is not in the leaſt ſenſibly warmer than the ice was before. A thermometer, applied to drops or ſmall ſtreams of water, immediately as it comes from the melting ice, will point to the ſame degree as when it is applied to the ice itſelf, or if there is any difference, it is too ſmall to deſerve notice. A great quantity, therefore, of the heat, or of the matter of heat, which enters into the melting ice, produces no other effect but to give it fluidity, without augmenting its ſenſible heat; it appears to be abſorbed and concealed within the water, ſo as not to be diſcoverable by the application of a thermometer.

219
Thermometer does not indicate the caloric abſorbed.

“ In order to underſtand this abſorption of heat into the melting ice, and concealment of it in the water, more diſtinctly, I made the following experiments.

“ The plan of the firſt was, to take a maſs of ice, and an equal quantity of water, in ſeparate veſſels, of the ſame ſize and ſhape, and as nearly as poſſible of the ſame heat, to ſuſpend them in the air of a warm room, and, by obſerving with a thermometer the celerity with which the water is heated, or receives heat, to learn the celerity with which it enters the ice; and the time neceſſary for melting the ice being alſo attended to, to form an eſtimate, from theſe two data, of the quantity of heat which enters the ice during its liquefaction.

220
Proved by experiments.

“ In order to prepare for this experiment, I choſe two thin globular glaſſes, four inches diameter, and very nearly of the ſame weight: I poured into one of them five ounces of pure water, and then ſet it in a mixture of ſnow and ſalt, that the water might be frozen into a ſmall maſs of ice. As ſoon as frozen, it was carried into a large empty hall, in which the air was not diſturbed or varied in its temperature during the progreſs of the experiment; and in this room the glaſs was ſupported, as it were, in mid air, by being ſet on a ring of ſtrong wire, which had a tail iſſuing from the ſide of it five inches long, and the end of this tail was fixed in the moſt projecting part of a reading deſk or pulpit: And in this ſituation the glaſs remained until the ice was completely melted.

221
Firſt experiment.

“ When the ice was thus placed, I ſet up the other globular glaſs preciſely in the ſame ſituation, and at the diſtance of 18 inches to one ſide, and into this I poured five ounces of water, previouſly cooled, as near to the coldneſs of melting ice as poſſible, viz. to 33°, and ſuſpended in it a very delicate thermometer, the bulb of which being in the centre of the water, and the tube being ſo placed, that without touching the thermometer, I could ſee the degree to which it pointed. I then began to obſerve the aſcent of this thermometer, at proper intervals, in order to learn with what celerity the water received heat, ſtirring the water gently with the end of a feather about a minute before each obſervation. The heat of the air, examined at a little diſtance from the glaſſes, was 47° of Fahrenheit's ſcale.

“ The thermometer aſſumed the temperature of the water in leſs than half a minute, after which, the riſe of it was obſerved every five or ten minutes, during half an hour. At the end of that time, the water was grown warmer than at firſt, by 7° degrees; and the temperature of it had riſen to the 40th degree of Fahrenheit's ſcale.

"The glaſs with the ice was, when firſt taken out of the freezing mixture, four or five degrees colder than melting ſnow, which I learned by applying the bulb of the thermometer to the bottom of it; but after ſome minutes, it had gained from the air thoſe four or five degrees, and was juſt beginning to melt, which point of time was then noted, and the glaſs left undiſturbed ten hours and a half. At the end of this time, I found only a very ſmall and ſpongy maſs of the ice remaining unmelted, in the centre of the upper ſurface of the water, but this alſo was totally melted in a few minutes more; and, introducing the bulb of the thermometer into the water, near the ſides of the glaſs, I found the water there was warmed to the 40th degree of Fahrenheit. From this it appears, that when a conſiderable part of the ice was melted, and the quantity of water around it was increaſing, the heat was not tranſmitted through this water to the remaining ice altogether ſo faſt as it was received by the water; which is eaſily underſtood, if we conſider that the diſtance between the remaining ice and the external ſurface of the veſſel through which the heat entered, was gradually increaſing, and that heat always requires time to paſs through bodies, or to be communicated from one part of them to another.

"It appears, therefore, from this experiment, that it was neceſſary that the glaſs with the ice receive heat from the air of the room during 21 half-hours, in order to melt the ice into water, and to heat that water to the 40th degree of Fahrenheit. During all this time, it was receiving the heat, or matter of heat, with the ſame celerity (very nearly) with which the water-glaſs received it during the ſingle half-hour in the firſt part of the experiment. For, as the water received it with a celerity which was diminiſhing gradually during that half-hour, in conſequence of the diminution of difference between its degrees of heat and that of air; ſo the glaſs with the ice alſo received heat with a diminiſhing celerity, which correſponded exactly with that of the water-glaſs, only that the progreſſion of this diminution was much more ſlow, and correſponded to the whole time which the water ſurrounding the ice required to become warmed to the 40th degree of Fahrenheit. The whole quantity of heat, therefore, received by the ice-glaſs during the 21 half-hours, was 21 times the quantity received by the water-glaſs during the ſingle half-hour. It was, therefore, a quantity of heat, which, had it been added to liquid water, would have made it warmer by $\overline{40-33}\times 21$, or 7×21, or 147 degrees. No part of this heat, however, appeared in the ice water, except 8 degrees; the remaining 139 or 140 degrees had been abſorbed by the melting ice, and were concealed in the water into which it was changed.

"The communication of heat to the melting ice was eaſily perceived, during the whole time of its expoſition, by feeling the ſtream of cold air which deſcended from the glaſs.

"This experiment was an analyſis of the manner in which ice is melted by the heat of the air in ordinary circumſtances.

"But another obvious method of melting ice occurred to me, in which it would be ſtill more eaſy to perceive the abſorption and concealment of heat, and this was the action of warm water.

222 Second experiment.

"When hot and cold water are mixed together, the exceſs of heat contained in the hot water is equally diſtributed in an inſtant through the whole mixture, and raiſes the temperature of it according to the greatneſs of the exceſs of temperature, and the proportion which the hot water bore to the cold. If the quantities of hot and cold water are equal, the temperature is the middle degree between that of the hot and that of the cold. No part of the heat diſappears on this occaſion, ſo far as we can perceive, but the intenſity of it only is diminiſhed, by its being diffuſed through a larger quantity of matter. I was, therefore, obvious, that if a quantity of heat is abſorbed, and diſappears in the melting of ice, this would eaſily be perceived when the ice is melted with warm water.

"To make this experiment, I firſt froze a quantity of water in the neck of a broken retort, in order to have a maſs of ice of an oblong form.

"At the ſame time I heated a quantity of water, nearly equal in weight to the ice, in a very thin globular glaſs, the mouth of which was ſufficiently wide to take in the piece of ice. The water was heated by a ſmall ſpirit of wine lamp applied to the bottom of the glaſs; it was alſo ſtirred with the end of a feather, and a thermometer hung in it.

"While the water was heating, the maſs of ice was taken out of the mould in which it had been formed, and was expoſed to the air of a temperate room, until it was perceived to be beginning to melt over the whole of its ſurface.

"I then put a woollen glove on my left hand, and taking hold of the ice, I wiped it quite dry with a linen towel, laid it in the ſcale of a balance on a piece of flannel, and haſtily counterpoiſed it with ſand in the oppoſite ſcale, that I might examine the weight of it afterwards; and I immediately plunged it into the hot water, and extinguiſhed the lamp at the ſame time. The lamp being ſmall, the heat of the water had been increaſing very ſlowly, and had almoſt ceaſed to increaſe; and being examined immediately before I put the ice into it, the temperature was found to be juſt 190 degrees. The ice was all melted in a few ſeconds, and produced a mixture, the temperature of which was 53 degrees.

"The weight of the ice, when put into the hot water, was ſeven ounces three drams and a half. The weight of the glaſs, with the whole mixture in it, was 16 ounces, ſeven drams, and ſeven grains. The weight of the glaſs alone was nearly one ounce.

"In conſidering this experiment, we may overlook quantities leſs than half a dram, or 30 grains, and reckon the quantities of the different articles by the number of half-drams in each.

Thus the weight of the ice was	119	half-drams.
——— Hot water	135	
——— Mixture	254	
——— Glaſs alone	16	

"The melting of the ice was effected, not only by the heat of the hot water, but alſo by that of the glaſs. And, by other experiments, I learned that 16 parts of hot glaſs have more power in heating cold bodies, than eight parts of equally hot water; we may therefore ſubſtitute, in place of the 16 half-drams of warm glaſs, eight half-drams of warm water, which, added to the above quantity of warm water, make up 143 half-drams.

"The heat of this warm water was 190 degrees, that is 158 hotter than the ice; and if this heat had abated in the mixture only in conſequence of the quantity and coldneſs of the ice, and if nothing had happened when the ice was put in, but merely a communication of this heat, and an equal diſtribution of it through the mixture, the temperature of the mixture ſhould have been 158, viz. the exceſs of heat in the warm water, multiplied by 143, the quantity of the warm matter, and divided by 262, the quantity of the whole, which gives 86.

223 Caloric is abſorbed.

"The mixture ſhould have been 86 degrees warmer than melting ice; but it was found only 21 degrees warmer. Therefore a quantity of heat has diſappeared, which, if it had remained in a ſenſible ſtate, would have made the whole mixture and glaſs warmer by 65 degrees than they were actually found to be. But this quantity of heat would be ſufficient for increaſing, by 143 degrees, the heat of a quantity of water, equal in weight to the ice alone. It was, however, abſorbed by the ice, without in the leaſt increaſing its ſenſible heat (o).

"The reſult of this experiment coincides ſufficiently with that of the former; the difference is not greater than what may be expected in ſimilar experiments, and might ariſe from the accident of the central parts of the maſs of ice being colder than the ſurface, by one or two degrees.

"I have, in the ſame manner, put a lump of ice into an equal quantity of water, heated to the temperature 176, and the reſult was, that the fluid was no hotter than water juſt ready to freeze. Nay, if a little ſea ſalt be added to the water, and it be heated only to 166 or 170, we ſhall produce a fluid ſenſibly colder than the ice was in the beginning, which has appeared a curious and puzzling thing to thoſe unacquainted with the general fact.

"It is, therefore, proved that the phenomena which attend the melting of ice in different circumſtances, are inconſiſtent with the common opinion which was eſtabliſhed upon this ſubject, and that they ſupport the one which I have propoſed *."

* *Black's Lect.* vol. i. p. 125.

6. Theſe experiments ſhew clearly and incontrovertibly, that the converſion of ice into water is owing to the abſorption of a certain portion of caloric; and that the quantity of caloric abſorbed is equal to what would have raiſed the temperature of a body which remained unchanged, as for inſtance water, 140°. Theſe 140° therefore, have diſappeared, (for no increaſe of temperature is indicated by the thermometer), have been abſorbed by the ice, and are neceſſary to reduce it to the liquid ſtate. This portion of caloric which had thus diſappeared, Dr Black called *latent heat*, becauſe in this ſtate of combination its preſence was not indicated by the thermometer. By others this has been called *the caloric of fluidity*.

224 Called *latent heat.*

225 Experiments on other bodies prove the ſame thing.

7. In the progreſs of theſe inveſtigations, experiments were made on other ſubſtances, which clearly ſhewed that their fluidity is owing to the ſame cauſe. Theſe experiments were made on wax, tallow, ſpermaceti, ſulphur, alum, nitre, and ſome of the metals. The late ingenious Dr Irvine, the pupil of Dr Black, and who eſſentially aſſiſted him in many of his experiments, aſcertained the quantity of caloric which was neceſſary for the fluidity of the following ſubſtances; which, when compared with that of ice, will ſhew that the quantity of the caloric of fluidity increaſes with the temperature at which the body is converted into the liquid ſtate.

Spermaceti,	148°
Bees wax,	175
Tin,	500 *

* *Black's Lect.* vol. i. p. 137.

226 Softneſs and malleability owing to the ſame cauſe.

8. Dr Black farther obſerves on the operation of this cauſe, that there is reaſon to think, that not only the fluidity of bodies, but even the ſoftneſs of ſuch as are rendered plaſtic by heat, depends on a quantity of heat combined with them, in the form of latent heat; and that the malleability and ductility of metals depend upon the ſame cauſe. For, while they are extended under the hammer, they become warm, and in ſome caſes very hot; but at the ſame time they become rigid, and are no longer malleable. They have loſt their toughneſs and ſoftneſs. To reſtore this, they muſt be annealed or made hot in the fire, and allowed to cool. Thus, they recover their malleability, of which they may be again deprived by a ſecond hammering.

227 Temperature at which bodies become fluid conſtant.

9. The temperature at which ſolid bodies begin to be converted into the liquid ſtate, is always conſtant; and till they are raiſed to this temperature, no change takes place. Water in the ſolid ſtate, or ice, always remains unchanged till it is placed in a temperature above 32°. This point, which is called the *melting* point, is conſtant in the ſame body, but is very different in different bodies. The following table exhibits the melting point of a number of ſolid bodies.

Lead,	594°
Biſmuth,	576
Tin,	442
Sulphur,	212
Wax,	142
Spermaceti,	133
Phoſphorus,	100
Tallow,	92
Oil of aniſe,	50
Olive oil,	36
Ice,	32
Milk,	30
Vinegar,	28
Blood,	25
Oil of bergamot,	23
Wines,	20

(o) "Theſe two experiments. and the reaſoning which accompanies them, were read by me in the Philoſophical Club, or Society of Profeſſors and others in the Univerſity of Glaſgow, in the year 1762."

Oil of turpentine,	14°
Sulphuric acid,	36
Mercury,	39
Liquid ammonia,	46
Ether,	46
Nitric acid.	66

3. Of Vapour.

228 Water changed into vapour.

1. If, after a maſs of ice is converted into water or the liquid ſtate, the application of heat be continued to that water, it undergoes other changes, and exhibits very different phenomena. If the temperature be raiſed ſufficiently high, the water becomes agitated with an inteſtine motion, and if it is ſupplied with a ſufficient quantity of caloric, the whole of the water is diſſipated. This agitation of the water, it is well known, is called in common language, *boiling*.

229 Boiling, what.

230 Boiling point conſtant;

2. As ſolid bodies which are capable of being converted into the liquid ſtate by an increaſe of caloric, have a certain determinate temperature, ſo, many of thoſe bodies which are capable of aſſuming the form of an elaſtic fluid, undergo this change, only when they are raiſed to a certain temperature. Some liquids, indeed aſſume the form of vapour at all temperatures, which is the caſe with water, with volatile oils, ſpirits of wine and ether. This change is called *ſpontaneous evaporation*; but there are others which remain fixed and unchanged till the temperature is raiſed to that point at which they boil. Boiling is nothing elſe but the rapid converſion of the liquid into vapour. The heat being applied to the bottom of the veſſel which contains the liquid, the particles at the bottom firſt aſſume the elaſtic form; and as they riſe through the liquid, cauſe it to be violently agitated. This boiling point, under the ſame preſſure, is always the ſame in the ſame liquid; and however ſtrong the heat that may be applied, or however long it may be continued, the temperature of the liquid, in open veſſels, never riſes above this point. The boiling point of water, for inſtance, is 212°, and it never becomes hotter; on the contrary, if the ſame heat be continued, the whole is diſſipated, and converted into vapour.

Table ſhewing the boiling point of ſeveral liquids.

Ether,	98°
Ammonia,	140
Alcohol,	176
Water,	212
Muriat of lime,	230
Nitric acid,	248
Phoſphorus,	554
Oil of turpentine,	560
Sulphur,	570
Sulphuric acid,	590
Linſeed oil,	600
Mercury,	660

231 but varies with preſſure.

3. But this boiling point is found to vary conſiderably, and this variation depends on the preſſure on the ſurface of the liquid. When the preſſure is diminiſhed, liquids boil at a lower temperature; but when this preſſure is increaſed, they require a higher temperature to produce boiling. Water boils at a low temperature on the top of a high mountain, or in the vacuum of an air pump, where the preſſure is greatly diminiſhed; but when it is confined in cloſe veſſels, as in Papin's digeſter, the temperature may be raiſed to 300° or 400° without boiling.

232 Law of latent heat extended.

4. The general law which was diſcovered by Dr Black, of the converſion of ſolids into liquids, was alſo applied by him to account for the change of liquids into elaſtic fluids. This was proved by the following experiments.

" *Experiment* 1.—I procured (ſays Dr Black) ſome cylindrical tin-plate veſſels, about four or five inches diameter, and flat-bottomed. Putting a ſmall quantity of water into them, of the temperature 50°, I ſet them upon a red-hot kitchen table, that is, a caſt-iron plate, having a furnace of burning fuel below it, taking care that the fire ſhould be pretty regular. After four minutes, the water began ſenſibly to boil, and in 20 minutes more, it was all boiled off. This experiment was made 4th October 1762.

" *Experiment* 2.—Two flat-bottomed veſſels, like the former, were ſet on the iron plate, with eight ounces of water in each, of the temperature 50°. They both began to boil at the end of three and a half minutes, and in eighteen minutes more, all the water was boiled off.

" *Experiment* 3.—The ſame veſſels were again ſupplied with 12 ounces of water in each, alſo of the temperature 50°. Both began to boil at the end of ſix and a quarter minutes, and the water was all boiled off from the one in 28 minutes, and from the other in ſomething more than 29.

" I reaſoned from theſe experiments in the following manner: The veſſels in the firſt experiment received 162 degrees of heat in four minutes, or 40½ degrees each minute. If we, therefore, ſuppoſe that the heat enters equally faſt during the whole ebullition, we muſt ſuppoſe that 810 degrees of heat have been abſorbed by the water, and are contained in its vapour. Since this vapour is no hotter than boiling water, the heat is contained in it in a latent ſtate, if we conſider it only as the cauſe of warmth. Its preſence is ſufficiently indicated, however, by the vaporous or expanſive form which the water has now acquired.

233 Quantity of caloric in vapour.

" In experiment ſecond, the heat abſorbed, and rendered latent, ſeems to be about 830.

" In the third experiment, the heat abſorbed ſeems to be ſomewhat leſs, viz. about 750. The time of riſing to the boiling heat, in experiment third, has nearly the ſame proportion to that in experiment firſt, that the quantities of water have. The deficiency, therefore, in the heat abſorbed, has been probably only apparent, and ariſing from irregularity in the fire. Upon the whole, the conformity of their reſults with my conjecture was ſufficient to confirm me in my opinion of its juſtice. In the courſe of further experiments made both by myſelf and by ſome friends, and in which the utmoſt care was taken to procure a perfect uniformity in the heat applied, the abſorption was found extremely regular, and amounted at an average to about 810 degees.

234 Other proofs of caloric abſorbed in vapour.

" There are other caſes where this abſorption appears in a much more ſingular manner. I put into a very ſtrong phial, about as much water as half filled it, and I corked it cloſe. The phial was placed in a ſand-pot, which was gradually heated, until the ſand and phial were ſeveral degrees above the common vaporific point of water. I was curious to know what would be the effect of ſuddenly removing the preſſure of the air, which is well known to prevent water from boiling. The water boiled a very ſhort while, but the ebullition gradually decreaſed, till it was almoſt inſenſible. Here the formation of more vapour was oppoſed by a very ſtrong preſſure, proceeding from the quantity of vapour already accumulated, and confined in the upper part of the phial, and from the increaſed elaſticity of this vapour, by the increaſe of its heat. When matters were in this ſtate, I drew out the cork. Now, according to the common opinion of the formation of vapour by heat, it was to be expected that the whole of the water would ſuddenly aſſume the vaporous form, becauſe it was all heated above the vaporific point. But I was beginning by this time to expect a different event, becauſe I could not ſee whence the heat was to be ſupplied, which the water muſt contain when in the form of vapour. Accordingly, it happened as I expected; a portion only of the water was converted into vapour, which ruſhed out of the phial with a conſiderable exploſion, carrying along with it ſome drops of water. But, what was moſt intereſting to me in this experiment was, that the heat of what remained was reduced in an inſtant to the ordinary boiling point. Here, therefore, it was evident, that all that exceſs of heat which the water had contained above the boiling point, was ſpent in converting only a portion of it into vapour. This is plainly inconſiſtent with the common opinion, that nothing more is neceſſary for water's exiſting in a vaporous form under the preſſure of the atmoſphere, than its being raiſed to a certain temperature. The experiment makes it more probable, that if the influx of heat could at that inſtant have been prevented, it would have remained in the form of water, although raiſed, in a very ſenſible degree, above the boiling temperature.

I was anxious to learn whether the heat which diſappeared in this experiment was in an accurate proportion to the quantity of vapour produced, or the quantity of water that had diſappeared. But the drops of water that were hurried along by the exploſion without being converted into vapour, made it impoſſible for me to aſcertain this with any tolerable accuracy, although I repeated the experiment ſeveral times.

235
The caloric abſorbed in proportion to the quantity of vapour.

“ This experiment was afterwards made by my friend Mr Watt, in a very ſatisfactory manner. His ſtudies for the improvement of his ſteam-engine, gave him a great intereſt in every thing relating to the production of ſteam. He put three inches of water into a ſmall copper digeſter, and, ſcrewing on the lid, he left the ſafety-valve open. He then ſet it on a clear fire of coaks, and after it began to boil and produce ſteam, he allowed it to remain on the fire half an hour, with the valve open. Then, taking it off the fire, he found that an inch of water had boiled away. In the next place, he reſtored that inch of water, ſcrewed on the lid, and ſet it on the fire; and as ſoon as it began to boil, he ſhut the ſafety-valve, and allowed it to remain on the fire half an hour as before. The temperature of the whole was many degrees above the boiling point. He took it off the fire, and ſet it upon aſhes, and opened the valve a very ſmall matter. The ſteam ruſhed out with great violence, making a ſhrieking noiſe for about two minutes. When this had ceaſed, he ſhut the valve, and allowed all to cool. When he opened it, he found that an inch of water was conſumed.

“ It is reaſonable to conclude from this experiment, that nearly as much heat was expended during the blowing of the ſteam-pipe, as had been formerly expended in boiling off the inch of water. For, before opening the valve, the temperature was many degrees above the boiling point, and all this diſappeared with the vapour. The ſame inference may be drawn from the time that the digeſter continued upon the fire with the valve ſhut, becauſe we may conclude that the heat was entering nearly at the ſame rate during the whole time. It is plain, however, that the experiment is not of ſuch a kind as to admit of nice calculation; but it is abundantly ſufficient to ſhew that a prodigious quantity of heat had eſcaped along with the particles of vapour produced from an inch of water. The water that remained could not be hotter than the boiling point, nor could the veſſel be hotter, otherwiſe it would have heated the water, and converted it into vapour. The heat, therefore, did not eſcape along with the vapour, but *in* it, probably united to every particle, as one of the ingredients of its vaporous conſtitution. And as ice, united with a certain quantity of heat, is water; ſo water, united with another quantity of heat, is ſteam or vapour *.”

236
Confirmed by Dr Irvine.

The following experiment made by the late Dr Irvine of Glaſgow, at the deſire of Dr Black, and recorded by the latter, is a ſtill farther confirmation of the general fact of the converſion of liquids into elaſtic fluids, by combining with caloric.

“ Five meaſures (each containing 4 lb. 5 oz. and 6 dr. avoirdupois) of water, of the temperature 52°, were poured into a ſmall ſtill in the laboratory. The fire had been kindled about 40 minutes before, and was come to a clear and uniform ſtate. The ſtill was ſet into the furnace, and, in an hour and 20 minutes, the firſt drop came from the worm; and in three hours and 45 minutes more, three meaſures of water were diſtilled, and the experiment ended. The refrigeratory contained 38 meaſures of water, of which the temperature, at the beginning of the experiment, was 52°. When one meaſure had come over, the water in the refrigeratory was at 76°. When two had come over, it was at 100°; and when three had come over, it was at 123°.

“ In this experiment, the heat, which emerged from three meaſures of water, had raiſed the temperature of the water in the refrigeratory from 52° to 123°, or 71°. Now 3 is to 38 as 71 to 899⅓ and the heat would have raiſed the three meaſures 899⅓ degrees in its temperature, if this had been poſſible without converting it into vapour. The heat of the vapour from which this emerged, was 212°, or 160° more than that of the water. Taking this from 899°, there remains 739°, the heat contained in the vapour in a latent ſtate.

“ But this muſt be ſenſibly leſs than the truth. During the experiment, the veſſels were very warm—the head of the ſtill as hot as boiling water, and the refrigeratory gradually riſing from 52°, which was within a degree or two of the temperature of the air of the laboratory, to 123°. A very conſiderable portion of the latent heat of the ſteam muſt have been carried off by the air in contact with a conſiderable ſurface, ſome of which was exceedingly hot. A great deal muſt alſo have been carried off in the ſteam which aroſe very ſenſibly from the water in the refrigeratory, towards the end of the experiment. Mr Irvine alſo obſerved, that, during the diſtillation, the temperature of the water which ran from the worm was about 11° hotter than the water in the refrigeratory. The ſteam, therefore, at a medium, was not 160° hotter than the water which ran from the worm, but 125°, its mean temperature being about 87°. This conſideration alone will make the latent heat of the ſteam not leſs than 774 degrees, without any allowance for waſte.

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* *Black's Lect.* vol. i. p. 161.

"Some compariſon may alſo be made between the heat expended in the production of the ſteam, and that which emerges during its condenſation. The time which elapſed during the raiſing of the temperature of the five meaſures of water from 52° to 212°, that is 160°, was one hour and 20 minutes, or 80′,—and 225′ elapſed during the boiling off of three meaſures. Therefore, ſince 80 is to 225 as 160 to 450, as much heat was expended as would have raiſed the five meaſures 450° in temperature. This would have raiſed three meaſures 750° above the boiling heat already produced. This gives 750 for the latent heat of the ſteam, beſides what was unavoidably loſt by communication to the ambient air, and what was expended in heating the veſſels *."

237 Caloric of ſteam eſtimated by Watt.

In ſome experiments made by Mr Watt, who alſo aſſiſted Dr Black in conducting theſe invaluable experiments, it appears that the latent heat of ſteam is from 900° to 950°. This he diſcovered by obſerving the quantity of caloric which was abſorbed by the water in its converſion into ſteam or vapour, and the quantity given out, when that vapour returned to the ſtate of water.

238 By Lavoiſier.

The value of the latent heat of ſteam, eſtimated by the experiments of M. Lavoiſier, amounts to more than 1000°.

5. Thus is this general law eſtabliſhed, that all liquids are converted into elaſtic fluids, by combining with a certain portion of caloric. This portion of caloric is not indicated by the thermometer, and is therefore ſaid to be latent heat, as we already mentioned; but when the elaſtic fluid returns to the liquid ſtate, it again becomes ſenſible, and preciſely the ſame quantity is extricated which was abſorbed.

239 Elaſticity of all vapour the ſame as that of water with the ſame increaſe of temperature.

6. It is an object of ſome importance to aſcertain the elaſtic force of vapour, and the ratio of the increaſe of this elaſticity by increaſe of temperature. The elaſticity of vapour which is formed by a liquid boiling in the open air, is equal to the preſſure of the atmoſphere; and it has been aſcertained by the experiments of Mr Dalton and of M. Gay-Luſſac, that the elaſticity of all elaſtic fluids is the ſame with that of the vapour of water, with the ſame increaſe or diminution of temperature from the boiling point. If then, the boiling point of any liquid be known, the elaſticity of its vapour may be diſcovered, by comparing it with the elaſticity of the ſteam of water, the ſame number of degrees above or below the boiling point. In the following table, conſtructed by Mr Dalton from his experiments and calculations, the elaſticity of the vapour of water is given for every temperature from 40° to 325°. To find the elaſticity of the vapour of ether at 40° below its boiling point, which is 98°, take 40° from 98°, there remains 58, and the ſame number from 212° the boiling point of water, there remains 172°, oppoſite to which number in the table is 12.73, which is the elaſticity of the ſteam of water at 172°, and alſo the elaſticity of the vapour of ether at 58°.

Table of the Force of Vapour from Water in every temperature, from that of Congelation of Mercury, or 40° below Zero of Fahrenheit, to 325°†.

Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.
-40°	.013	41°	.273	88	1.28
-30	.020	42	.283	89	1.32
-20	.030	43	.294	90	1.36
-10	.040	44	.305	91	1.40
		45	.316	92	1.44
0	.064	46	.328	93	1.48
1	.066	47	.339	94	1.53
2	.068	48	.351	95	1.58
3	.071	49	.363	96	1.63
4	.074	50	.375	97	1.68
5	.076	51	.388	98	1.74
6	.079	52	.401	99	1.80
7	.082	53	.415	100	1.86
8	.085	54	.429	101	1.92
9	.087	55	.443	102	1.98
10	.090	56	.458	103	2.04
11	.093	57	.474	104	2.11
12	.096	58	.490	105	2.18
13	.100	59	.507	106	2.25
14	.104	60	.524	107	2.32
15	.108	61	.542	108	2.39
16	.112	62	.560	109	2.46
17	.116	63	.578	110	2.53
18	.120	64	.597	111	2.60
19	.124	65	.616	112	2.68
20	.129	66	.635	113	2.76
21	.134	67	.655	114	2.84
22	.139	68	.676	115	2.92
23	.144	69	.698	116	3.00
24	.150	70	.721	117	3.06
25	.156	71	.745	118	3.16
26	.162	72	.770	119	3.25
27	.168	73	.796	120	3.33
28	.174	74	.823	121	3.42
29	.180	75	.851	122	3.50
30	.186	76	.880	123	3.59
31	.193	77	.910	124	3.69
		78	.940	125	3.79
32	.200	79	.971	126	3.89
33	.207	80	1.00	127	4.00
34	.214	81	1.04	128	4.11
35	.221	82	1.07	129	4.22
36	.229	83	1.10	130	4.34
37	.237	84	1.14	131	4.47
38	.245	85	1.17	132	4.60
39	.254	86	1.21	133	4.73
40	.263	87	1.24	134	4.86

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* *Lect.* vol. i. p. 173.

† *Manch. Mem.* vol. v. p. 559.

Table Continued.

Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.
135°	5.00	190°	19.00	244°	53.03
136	5.14	191	19.42	245	53.88
137	5.29	192	19.86	246	54.68
138	5.44	193	20.32	247	55.54
139	5.59	194	20.77	248	56.42
140	5.74	195	21.22	249	57.31
141	5.90	196	21.68	250	58.21
142	6.05	197	22.13	251	59.12
143	6.21	198	22.69	252	60.05
144	6.37	199	23.16	253	61.00
145	6.53	200	23.64	254	61.92
146	6.70	201	24.12	255	62.85
147	6.87	202	24.61	256	63.76
148	7.05	203	25.10	257	64.82
149	7.23	204	25.61	258	65.78
150	7.42	205	26.13	259	66.75
151	7.61	206	26.66	260	67.73
152	7.81	207	27.20	261	68.72
153	8.01	208	27.74	262	69.72
154	8.20	209	28.29	263	70.73
155	8.40	210	28.84	264	71.74
156	8.60	211	29.41	265	72.76
157	8.81	212	30.00	266	73.77
158	9.02			267	74.79
159	9.24	213	30.60	268	75.80
160	9.46	214	31.21	269	76.82
161	9.68	215	31.83	270	77.85
162	9.91	216	32.46	271	78.89
163	10.15	217	33.09	272	79.94
164	10.41	218	33.72	273	80.98
165	10.68	219	34.35	274	82.01
166	10.96	220	34.99	275	83.13
167	11.25	221	35.63	276	84.35
168	11.54	222	36.25	277	85.47
169	11.83	223	36.88	278	86.50
170	12.13	224	37.53	279	87.63
171	12.43	225	38.20	280	88.75
172	12.73	226	38.89	281	89.87
173	13.02	227	39.59	282	90.99
174	13.32	228	40.30	283	92.11
175	13.62	229	41.02	284	93.23
176	13.92	230	41.75	285	94.35
177	14.22	231	42.49	286	95.48
178	14.52	232	43.24	287	96.64
179	14.83	233	44.00	288	97.80
180	15.15	234	44.78	289	98.96
181	15.50	235	45.58	290	100.12
182	15.86	236	46.39	291	101.28
183	16.23	237	47.20	292	102.45
184	16.61	238	48.02	293	103.63
185	17.00	239	48.84	294	104.80
186	17.40	240	49.67	295	105.97
187	17.80	241	50.50	296	107.14
188	18.20	242	51.34	297	108.31
189	18.60	243	52.18	298	109.48

Table Continued.

Temperature.	Force of Vap. in inches of Mercury	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.
299°	110.64	308°	121.20	317°	131.57
300	111.81	309	122.37	318	132.72
301	112.98	310	123.53	319	133.86
302	114.15	311	124.69	320	135.00
303	115.32	312	125.85	321	136.14
304	116.50	313	127.00	322	137.28
305	117.68	314	128.15	323	138.42
306	118.86	315	129.29	324	139.56
307	110.03	316	130.43	325	130.70

SECT. III. *Of the MOTION of CALORIC.*

240 Velocity of caloric equal to that of light.

1. It appears that the motion of caloric, when it is not interrupted, is equal in velocity to that of light. When therefore it is emitted by one body, it moves on with this velocity till it is received by another. This has been called the *tranſmiſſion* or *radiation* of heat. This radiation or ſeparation of heat from any body, ariſes from the force with which it is connected with that body being diminiſhed; that is, when a greater quantity of caloric is accumulated in that body than it can contain. The experiments of Dr Herſchel ſhew, that heat is radiated, refracted and reflected, in the ſame manner as light. The reflection of caloric has alſo been proved by the experiments of Mr Pictet formerly mentioned. But caloric is communicated from one body to another by direct contact of theſe bodies.

241 Radiated.

242 Refracted

243 and reflected.

244 Is communicated by contact.

2. It is well known that a cold body brought into contact with a warm body, in a certain time becomes hot; but this does not take place inſtantaneouſly; and the time neceſſary for one body to receive caloric from another, or for the different parts of the ſame body to acquire the ſame temperature, varies according to the nature and ſtate of theſe bodies. This is called the *conducting* power of bodies.

245 More rapidly in ſome bodies.

3. But as different bodies have different degrees of affinity for caloric, or contain different proportions of it, it muſt be ſeparated or abſorbed with greater or leſs facility. The motion of caloric therefore, in theſe different circumſtances, will be conſiderably varied in its celerity. This may be proved by direct experiment. If one extremity of two ſubſtances of different properties, as, for inſtance, a rod of iron and another of wood, be put into the fire, and the hand brought into contact with the other extremity, the rod of iron will ſoon be heated too much for the hand to bear, while the rod of wood will not have its temperature greatly increaſed. This ſhews, that there is a ſmaller quantity of caloric carried through the wood; or, in other words, the iron is a better conductor that the wood.

246 Good conductors.

4. All ſolid bodies are conductors of caloric, but they poſſeſs this power in very different degrees. Thoſe bodies which conduct caloric with facility are called *good* conductors, but thoſe through which it

paſſes with difficulty or very ſlowly, are ſaid to be *bad* conductors.

247 Bad conductors.

The motion of caloric from one body to another, or through the ſame body, is not altogether in proportion to their denſities, as might be ſuppoſed from the inſtance of the communication of caloric through wood and iron, juſt mentioned. Caloric is conducted very ſlowly through a more porous ſubſtance, ſuch as a maſs of cork, of wool, of feathers, or furs. It is on account of the ſlowneſs with which heat is conducted in theſe ſubſtances, that ſome of them are employed in the colder ſeaſons of the year, or in cold countries, as materials for clothing. The heat being ſlowly conducted through ſuch ſubſtances, they prevent the heat of the body from being diſſipated, or cut off the communication between the warm body and the cold air.

248 Their uſe.

And thus we ſee a wiſe proviſion of nature, in furniſhing all animals which are inhabitants of the colder regions of the earth, with a thick covering of fur or feathers. According to the experiments of Count Rumford, the conducting power of fur, feathers, ſilk, and wool, diminiſhes in proportion to the fineneſs of their texture.

249 Metals the beſt conductors.

Metallic ſubſtances are the beſt conductors of caloric; but among the metals it would appear that there is conſiderable variety in their conducting power, and this is not in proportion to their denſity, as appears from the experiments of Dr Ingenhouſz on the following metals, which are ſet down in the order of their conducting power *.

Silver,
Gold,
Copper,
Tin,
Platina,
Iron,
Steel,
Lead,

250 Conducting power of woods.

A ſet of experiments were made on the conducting power of different woods, by Profeſſor Mayer of Erlangen, of which the following are the reſults, compared with the conducting power of water †.

Water,	10.0
Ebony,	21.7
Crab apple,	27.4
Aſh,	38.0
Beech,	32.1
Hornbeam,	32.3
Plum tree,	32.5
Female oak,	32.6
Pear tree,	33.2
Birch,	34.1
Oak,	36.3
Pitch pine,	37.5
Alder,	38.4
Pine,	38.6
Fir,	38.9
Lime tree,	39.0

The experiments of Guyton ſhew, that the conducting power of charcoal is to that of fine ſand nearly in the proportion of 2 to 3 ‡.

5. Fluid bodies, as well as ſolids, are conductors of caloric; but they are found to conduct it ſo ſlowly, that it was at firſt ſuppoſed, they did not poſſeſs this power at all; that is, that the caloric was not conducted from particle to particle in fluids, ſimilar to what happens in ſolid bodies.

251 Fluids are conductors;

This opinion ſeemed to be ſupported by the nature and conſtitution of fluids, in which the particles have free motion among each other, ſo that when one ſet of particles acquire an additional quantity of caloric, their ſpecific gravity is neceſſarily diminiſhed, and they naturally change place with thoſe other particles of the fluid which have been leſs heated and are conſequently heavier. Theſe different appearances which were obſerved in the heating of fluids led Count Rumford, who made many ingenious experiments on this ſubject, to conclude, that fluids are heated, or conduct caloric, in a different manner from ſolids. In a ſpirit of wine thermometer, which was placed in a window to cool, he obſerved the fluid in the tube in rapid motion. There were two currents going in different directions, the one aſcending, and the other deſcending. The deſcending current occupied the ſides of the tube, and the aſcending current the middle. The currents were owing to the change in the ſpecific gravity of the particles, which being heated became lighter, and roſe to the top; the heavier particles at the ſame time deſcending. The particles which aſcended having reached the ſides or top of the tube, gave out their caloric, became ſpecifically heavier, and again fell to the bottom. The motion of the currents was conſiderably increaſed by the application of a cold body to the ſides of the tube. The count alſo repeated the experiment with linſeed oil, and alſo with water, in the latter of which he diſſolved potaſh, to bring its ſpecific gravity to that of amber, ſmall pieces of which he introduced, to obſerve the currents more diſtinctly. Theſe experiments were followed with the ſame reſult. When the temperature was increaſed or diminiſhed, the currents were ſet in motion, and only ceaſed when the temperature became equal to the ſurrounding bodies.

In proſecuting this ſubject, the count made other experiments, to aſcertain how far the heating or cooling of fluids is affected by a difference of fluidity. The thermometer which he employed in theſe experiments, has a copper bulb and a glaſs tube, and it was filled with linſeed oil. This was placed in the centre of a braſs cylinder, and the ſpace between the ſides of the cylinder and the thermometer, was 0.25175. The thermometer being ſecured, the cylinder was filled with 2176 grs. of pure water, and held in melting ſnow, till the thermometer fell to 32°. It was then immerſed in boiling water, and the thermometer roſe from 32° to 200° in 597″. The caloric which raiſed the thermometer muſt have been communicated to it through the water in the cylinder. The experiment was then varied, by boiling 192 grs. of ſtarch in the water in the cylinder. The thermometer now required 1109″ to riſe from 32° to 200°. The ſame experiment was repeated by mixing 192 grs. eider down with the ſame quantity of water, and alſo with a quantity of ſtewed apples. The reſult of theſe experiments will be ſeen in the following tables §.

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* *Journ. de Phyſ.* 1789.

† *Annal. de Chim.* vol. xxi. p. 43.

‡ *Ibid.* vol. xxvi. p. 227.

§ *Rumford*, Eſſay 7.

Time the Caloric was in paſſing into the Thermometer.

Temperature.	Through the Water and Starch.	Through the Water and Eiderdown.	Through ſtewed Apples.	Through pore Water.
	Seconds.	Seconds.	Seconds.	Seconds.
Therm. roſe from 32° to 200°, in	1109	949	$1096\frac{1}{2}$	597
Therm. roſe 80°, viz. from 80° to 160°, in	341	269	335	172

Time the Caloric was in paſſing out of the Thermometer.

Temperature.	Through the Water and Starch.	Through the Water and Eiderdown.	Through ſtewed Apples.	Through pure Water.
	Seconds.	Seconds.	Seconds.	Seconds.
Therm. fell from 200° to 40° in	1548	1541	$1749\frac{1}{2}$	103
Therm. fell 80°, viz. from 160° to 80°, in	468	460	520	277

The ſubſtances which were added to the water in theſe experiments, by diminiſhing its fluidity, had the effect of retarding the internal motions or currents by which the caloric is conducted through fluids. Thus, when ſtarch was mixed with water, it required nearly double the time to raiſe the thermometer to the ſame degree, as with pure water. From theſe, and from ſome other experiments, Count Rumford concluded, that fluid bodies are heated in a different manner from ſolids; that caloric is not communicated through fluids from particle to particle, but that all the particles individually come in contact with the heating body, and this is ſuppoſed to be the cauſe of the currents which are obſerved during the heating of fluids.

252 but worſe than ſolids.

5. Fluids no doubt acquire great part of their temperature in this manner; but it has been clearly proved by the experiments of others, that they are alſo conductors of caloric exactly the ſame way as ſolid bodies, but in an inferior degree. This has been eſtabliſhed in the moſt ſatisfactory manner by the experiments of Dr Thomſon * and Mr Murray †, which were publiſhed in Nicholſon's Journal; and alſo by another ſet of experiments by Mr Dalton, which were publiſhed in the Mancheſter Memoirs ‡. By theſe experiments it is demonſtrated, that fluids conduct caloric from the ſurface downwards; which could not be the caſe, were it only communicated through them by the aſcending currents of particles, in the way Count Rumford ſuppoſed: but they are worſe conductors of caloric than ſolids; that is, it paſſes through them much more ſlowly.

SECT. IV. *Of the* DISTRIBUTION *of* CALORIC.

If a number of bodies be expoſed to different temperatures, and then be all placed in the ſame temperature, or brought into contact with each other, they acquire in a certain time the ſame temperature.

253 All bodies acquire the ſame temperature in the ſame medium.

Thus, if one body be raiſed to the temperature of 200°, another to that of 100°, and a third to the temperature of 60°; and if theſe three bodies be placed in the temperature of 80°, they all indicate, in a ſhort time, the ſame temperature. The bodies which were at the temperature of 200° and 100° are reduced to 80°, and the temperature of the body at 60° riſes to the ſame. This is called the *diſtribution*, or the *equilibrium* of caloric. To whatever degree bodies are heated or cooled, they all acquire in time, the temperature of the ſurrounding medium, as it is indicated by the thermometer. It may therefore be received as a general law, *that all bodies which communicate freely with each other, and are ſubject to no inequality of external action, acquire the ſame temperature.*

254 Radiation not the ſole cauſe of cooling.

1. Bodies are deprived of caloric, not only by radiation from their ſurfaces, but it is alſo conducted by thoſe bodies with which the heated body comes in contact, and this depends greatly on the nature of the ſurrounding cold body. The experiments of Profeſſor Pictet and Count Rumford, however, ſhew, that radiation is not the only cauſe. By thoſe of the former it appeared, that hot bodies ſuſpended in the vacuum of an air-pump, cooled more ſlowly than in the open air; and by thoſe of the latter, the cooling was ſtill ſlower in the Torricellian vacuum.

255 Good conductors cool moſt rapidly.

2. The time requiſite for the heating or cooling of bodies depends much on their conducting power. A ſubſtance which is a good conductor of caloric cools much more rapidly than a bad conductor. Mercury and water heated to the ſame temperature cool in very different times; the mercury cools more than twice as faſt as the water in the ſame circumſtances. The time of the cooling of fluids has been conſidered as nearly in the inverſe ratio of their conducting power.

256 Diſtribution of caloric explained by Boerhaave, &c.

3. This equal diſtribution of caloric was attempted to be explained by Boerhaave, Muſchenbroeck, and others, by ſuppoſing that there is an equal quantity of caloric in every equal meaſure of ſpace, however that ſpace might be filled up with different bodies, and that theſe bodies floated, as it were, in this caloric. From this equal diſtribution of caloric in ſpace, they concluded that there was an equal quantity of caloric in all bodies, becauſe, whatever was the denſity or different circumſtances of bodies, they always indicated the ſame temperature to the thermometer. A cubic foot of gold, and a cubic foot of air, according to this theory, contained the ſame quantity of caloric.

257 By Pictet.

Profeſſor Pictet gave another explanation of this phenomenon. He ſuppoſed that the accumulation of caloric in a body increaſed the repulſive force between its particles, by the diminution of the diſtance between them. By the action of this repulſive force, the particles are driven off in all directions. This repulſion continues to act till it is oppoſed by a new force, which is the force of repulſion between the particles of caloric ſeparated from another body; and, till theſe two forces acquire the ſame intenſity, the particles of caloric continue to ſeparate from the hotter body. When the two forces are balanced, the bodies are of the ſame temperature. Thus, if two bodies of different temperatures are brought into contact with each other, the repulſive force of the particles of caloric in the hotter body is the greateſt, and therefore the particles tend to ſeparate from each other; but the repulſion between the particles of the colder body being leſs, they come nearer each other. The caloric from the hotter body continues to ſeparate, and to enter the colder body, till the two forces exactly balance each other, and then the temperature is the ſame *. But this theory, with all its ſimplicity and ingenuity, being unſatisfactory in accounting for the equilibrium of temperature, has been given up, even by its author.

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* Vol. iv. p. 529.

† Ibid. octavo, vol. i. p. 165.

‡ Vol. v. p. 373.

* *Eſſai ſur le Feu*, chap. i.

258 His theory unſatisfactory.

259 Prevoſt's theory.

4. Another theory has been propoſed by M. Prevoſt, profeſſor of philoſophy at Geneva. "Accuſtomed," ſays he, "for a long time, to conſider this ſubject in a different view from what had been formerly taken of it, I endeavoured to draw the attention of naturaliſts to this inveſtigation, in a memoir on the equilibrium of caloric †, and in my *reſearches on heat*‡. In theſe works, I believe it was firſt propoſed to ſubſtitute a moveable equilibrium in place of the immoveable equilibrium, the exiſtence of which had been generally admitted.

† *Journ. de Phyſ.* April 1791.

‡ Geneva, 1792.

"On this hypotheſis, it it is equally eaſy and ſatisfactory to account for the reflection of cold, as for that of heat. I conſider it indeed a characteriſtic of its truth; for theſe two facts being of the ſame kind, the theory that will account for the one, is applicable to the other. Before I proceed to ſtate in a few words the principle of this theory, I may premiſe, that I had the ſatisfaction of ſeeing it adopted by M. Pictet and others, who are well qualified to judge of it.

"Caloric is a diſcrete, agitated fluid: each particle of free caloric moves with immenſe velocity; one particle moves in one direction, and another particle moves in another, ſo that a heated body gives out calorific rays in all directions; and theſe particles are ſo far ſeparated from each other, that two or more currents may croſs each other, as is the caſe with light, without mutual diſturbance in their courſe. Conceiving this to be the conſtitution of caloric, if we ſuppoſe two contiguous ſpaces in which it abounds, there will be continual changes between theſe ſpaces. If in the two ſpaces caloric abounds equally, the exchanges will be equal; there will be an equilibrium. If one of the ſpaces contain more caloric than the other, the exchanges will be unequal. The cooleſt will receive more particles of caloric than it gives out, and after a ſufficient time, the continual repetition of theſe changes will reſtore the equilibrium §.

§ *Phil. Tranſ.* 1802.

"From theſe principles may be deduced all the laws of the increaſe and diminution of temperature. Let us ſuppoſe a body placed in a medium hotter than itſelf, and that this medium has a conſtant temperature. We may conſider the caloric of the medium as compoſed of two parts, the one equal to that of the body, and the other equal to the difference of the two. With regard to the firſt, the exchanges are equal; between the body and the medium there is an equilibrium. The exceſs of the heat of the medium may then only be conſidered; and relatively to this exceſs the body is abſolutely cold. Let us ſuppoſe that in one ſecond the body receives $\frac{1}{10}$ of this caloric; at the end of the firſt ſecond the exceſs will be no more than $\frac{9}{10}$: the $\frac{1}{10}$ of this new exceſs will paſs into the body during the next ſecond; and the exceſs will be reduced to $\frac{9}{10}$ of $\frac{9}{10}$; and in purſuing this, at the end of the third ſecond, the exceſs will be $(\frac{9}{10})^3$, and ſo on; ſo that, conformably to the obſerved law, the times increaſe in arithmetical progreſſion, and the differences decreaſe in geometrical progreſſion. In the ſame way may be eaſily deduced the law of the cooling of a body placed in a medium colder than itſelf. And thus the true theory of heat, founded on facts totally different from thoſe by which Richmann eſtabliſhed this law, neceſſarily leads us to it *.

* *Phil. Tranſ.* 1802. p. 444.

SECT. V. *Of the* QUANTITY *of* CALORIC *in Bodies.*

We have now treated in the former ſections of the effects of caloric, of its motion, and of its diffuſion in bodies; we are next to conſider the *quantity* of caloric which theſe bodies contain. This ſubject has occupied the attention and ſpeculations of many philoſophers. In theſe ſpeculations, two objects were kept in view, the one to aſcertain the whole quantity of caloric which a body contains, and the other the quantity of caloric neceſſary to raiſe different bodies to the ſame temperature. This laſt is uſually called *ſpecific caloric.*

1. OF SPECIFIC CALORIC.

260 explained.

1. If one lb. of water at the temperature of 100° be mixed with another lb. of water at the temperature of 50°, they will very ſoon acquire the ſame temperature, which will be the mean of the two temperatures. The pound of water at 100° will give out 25°, and the pound of water at 50° will receive 25°, which brings both to the temperature of 75°.

2. But if we take one pound of water at 100°, and one pound of mercury at 50°, the temperature, after mixing the water and the mercury, will not be 75°, the medium temperature in the former caſe. On the contrary, when the mixture is made, the temperature will be found to be 88°. The water, therefore, has loſt only 12°, and the mercury has gained 38°. If this experiment be reverſed, and one pound of water at 50° be mixed with a pound of mercury at 100, the temperature of the mixture will be found to be only 62°; ſo that in this caſe the mercury has given out 38°, and the water has received only 12°. In this experiment, therefore, it appears clearly, that different quantities of caloric are neceſſary to increaſe or diminiſh the temperature of different bodies; for, the quantity of caloric which raiſes water 12°, raiſes mercury no leſs than 38°. This quantity of caloric which bodies require to raiſe them to the ſame temperature, is called *ſpecific caloric.*

3. "It was formerly a common ſuppoſition," ſays Dr Black, "that the quantities of caloric required to increaſe the heat of different bodies by the ſame number of degrees, were directly in proportion to the quantity of matter in each; and, therefore, when the bodies were of equal ſize, the quantities of caloric were in proportion to their denſity. But very ſoon after I began to think of this ſubject, in the year 1760, I perceived that this opinion was a miſtake, and that the quantities of heat which different kinds of matter muſt receive, to reduce them to an equilibrium with one another, or to raiſe their temperature by an equal num-

ber of degrees, are not in proportion to the quantity of matter in each, but in proportions widely different to this, and for which no general principle or reaſon can yet be aſſigned *." This difference was firſt pointed out by Dr Black, which he ſtates in the above obſervations, and he diſtinguiſhed it by the term *capacity of bodies for heat.* Dr Black's method, which is given by Profeſſor Robiſon, is the following.

261 Dr Black's method.

"Dr Black eſtimated the capacities, by mixing the two bodies in equal maſſes, but of different temperatures; and then ſtated their *capacities as inverſely proportional to the changes of temperature of each by the mixture.* Thus, a pound of gold, of the temperature 150°, being ſuddenly mixed with a pound of water, of the temperature 50°, raiſes it to 55° nearly: Therefore the capacity of gold is to that of an equal weight of water as 5 to 95, or as 1 to 19; for the gold loſes 95°, and the water gains 5°.

"It will be moſt convenient to compare all bodies with water, and to expreſs the capacity of water by unity, or to call it 1. Let the quantity of the water be W, and its temperature w. Let the quantity of the other body be B, and its temperature b. Let the temperature of the mixture be m. The capacity of B is $\frac{W\times\overline{m-w}}{B\times\overline{b-m}}$, or when the water has been the hotter of the two, the capacity of B is $\frac{W\times\overline{w-m}}{B\times\overline{m-b}}$. In other words, *multiply the weight of the water by its change of temperature. Do the ſame for the other ſubſtance. Divide the firſt product by the ſecond. The quotient is the capacity of the other ſubſtance, that of water being accounted 1* † (P)."

4. This ſubject was ſtill farther proſecuted by other philoſophers, particularly by Dr Irvine of Glaſgow, Dr Crawford of London, and Profeſſor Wilcke of Stockholm.

262 Dr Crawford's.

The method which was employed by Dr Crawford was ſimilar to that of Dr Black. Two ſubſtances which were of different temperatures, were uniformly mixed; the change of temperature produced on each was obſerved, and this was conſidered as inverſely proportional to its ſpecific caloric.

263 Mr Wilcke's.

Mr Wilcke has aſcertained the ſpecific caloric of many metals, by a ſet of very ingenious experiments, which were conducted in the following manner. The metal which was the ſubject of the experiment, was firſt accurately weighed. The quantity employed was generally a pound. It was then ſuſpended by a thread, plunged into a veſſel of tin plate filled with boiling water, and allowed to remain till it reached a certain temperature indicated by the thermometer. A quantity of water at the temperature of 32°, exactly equal in weight to the metal, was put into another veſſel of tin plate. The metal was then immerſed in this veſſel, and ſuſpended in it ſo as to be kept free from the ſides and bottom. The temperature, at the moment when the metal and water were reduced to the ſame, was obſerved. The ſpecific caloric of the matter was then deduced by calculation from the change of temperature. He firſt calculated what the temperature would have been, if a quantity of water of equal weight with the metal, and of the ſame temperature, had been added to the ice-cold water. The following is the proceſs.

Let M be a quantity of water at the temperature C, m another quantity at the temperature c, and let their common temperature after mixture be x; according to a rule demonſtrated long ago by Richman, $x=\frac{MC+mc}{M+m}$. In the preſent caſe the quantities of water are equal, therefore M and m are each $=1$; C, the temperature of the ice-cold water, $=32$: therefore $\frac{MC+mc}{M+m}=\frac{32+c}{2}$. Now c is the temperature of the metal. Therefore if 32 be added to the temperature of the metal, and the whole be divided by 2, the quotient will expreſs the temperature of the mixture, if an equal weight of water with the metal, and of the ſame temperature with it, had been added to the ice-cold water inſtead of the metal.

He then calculated what the temperature of the mixture would have been, if inſtead of the metal, a quantity of water of the ſame temperature with it, and equal to the metal in bulk, had been added to the ice-cold water. As the weights of the ice-cold water and the metal are equal, their volumes are inverſely as their ſpecific gravities. Therefore the volume of ice-cold water is to a quantity of hot water equal in volume to the metal, as the ſpecific gravity of the metal to that of the water. Let M = volume of cold water, m = volume of hot water, g = ſpecific gravity of the metal, 1 = ſpecific gravity of water; then $m : M :: 1 : g$; hence $m=\frac{M}{g}=$ (M being made $=1$)

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* *Black's Lect.* v. i. p. 79.

† *Lect.* v. i. p. 506.

(P) "Theſe experiments require the moſt ſcrupulous attention to many circumſtances which may affect the reſult. 1. The mixture muſt be made in a very extended ſurface, that it may quickly attain the medium temperature. 2. The ſtuff which is poured into the other ſhould have the temperature of the room, that no change may happen in the pouring it out of its containing veſſel. 3. The effect of the veſſel in which the mixture is made muſt be conſidered. 4. Leſs chance of error will be incurred when the ſubſtances are of equal bulk. 5. The change of temperature of the mixture, during a few ſucceſſive moments, muſt be obſerved, in order to obtain the real temperature at the beginning. 6. No ſubſtances ſhould be mixed which produce any change of temperature by their chemical action, or which change their temperature, if mixed when of the ſame temperature. 7. Each ſubſtance muſt be compared in a variety of temperatures, leſt the ratio of the capacities ſhould be different in different temperatures.

"When all theſe circumſtances have been duly attended to, we obtain the meaſure of the *capacities* of different ſubſtances for heat." *Black's Lect.* v. i. p. 506.

$\frac{1}{g}$. Subſtituting this value of m in the formula, $\frac{MC+mc}{M+m}=x$, in which $M=1$ and $C=32$, x will be $=\frac{32g+c}{g+1}$. Therefore if the ſpecific gravity of the metal be multiplied by 32, and the temperature of the metal be added, and the ſum be divided by the ſpecific gravity of the metal $+1$, the quotient will expreſs the temperature to which the ice-cold water would be raiſed by adding to it a volume of water equal to that of the metal, and of the ſame temperature with it.

He then calculated how much water at the temperature of the metal it would take to raiſe the ice-cold water the ſame number of degrees which the metal had raiſed it. Let the temperature to which the metal had raiſed the ice-cold water be $=N$, if in the formula $\frac{MC+mc}{M+m}=x$, x be made $=N$, $M=1$, $C=32$, m will be $=\frac{N-32}{c-N}$. Therefore if from the temperature to which the ice-cold water was raiſed by the metal 32 be ſubtracted, and if from the temperature of the metal be ſubtracted the temperature to which it raiſed the water, and the firſt remainder be divided by the laſt, the quotient will expreſs the quantity of water of the temperature of the metal which would have raiſed the ice-cold water the ſame number of degrees that the metal did.

Now $\frac{N-32}{c-N}$ expreſſes the ſpecific caloric of the metal, that of water being $=1$. For (neglecting the ſmall difference occaſioned by the difference of temperature) the weight and volume of the ice-cold water are to the weight and volume of the hot water as 1 to $\frac{N-32}{c-N}$, and the number of particles of water in each are in the ſame proportion. But the metal is equal in weight to the ice-cold water, it muſt therefore contain as many particles of matter; therefore the quantity of matter in the metal muſt be to that in the hot water as 1 to $\frac{N-32}{c-N}$. But they gave out the ſame quantity of caloric; which, being divided equally among their particles, gives to each particle a quantity of caloric inverſely as the bulks of the metal and water; that is, the ſpecific caloric of the water is to that of the metal as 1 to $\frac{N-32}{c-N}$ (R).

It will now be proper to give a ſpecimen or two of his experiments, and the calculations founded on them, as above deſcribed.

GOLD. *Specific Gravity* 19.040.

Number of experiments.	Temperature of the metal.	Temper. to which the metal raiſed the water at 32°.	Temper. to which it would have been raiſed by a quantity of water equal in weight and heat to the metal.	Temper. to which it would have been raiſed by water equal in bulk and temperature to the metal.	Denominator of the fraction $\frac{N-32}{c-N}=\frac{1}{\frac{c-N}{N-32}}$, the numerator being 1.
1	163.4°	38.3°	97.7°	38.555°	19.857
2	144.5	37.4	88.25	37.58	19.833
3	127.4	36.5	79.7	36.68	20.500
4	118.4	36.05	75.2	36.15	20.333
5	103.1	35.6	65.75	35.42	18.750
6	95	34.45	63.5	35.06	19.000

Mean 19.712

LEAD.

(R) All theſe formulas have been altered to make them correſpond with Fahrenheit's thermometer. They are a good deal ſimpler when the experiments are made with Celſius's thermometer, as Mr Wilcke did. In it the freezing point is zero; and conſequently inſtead of 32 in the formula, 0 is always ſubſtituted.

LEAD. *Specific Gravity* 11.456.

Number of experiments.	Temperature of the metal.	Temper. to which the metal raiſed the water at 32°.	Temper. to which the water would have been raiſed by a quantity of water equal in weight and heat to the metal.	Temper. to which the water would have been raiſed by water equal in bulk and temperature to the metal.	Denominator of the fraction. $\frac{1}{\frac{c-N}{N-32}}$
1	186.8	38.3	109.4	44.425	23.571
2	181.40	37.85	106.7	43.473	24.538
3	165.2	37.4	98.6	42.692	23.666
4	163.4	37.4	97.7	42.548	23.333
5	136.4	36.5	84.2	40.344	22.200
6	131	36.05	81.5	39.947	24.700
7	126.5	36.05	79.25	39.585	22.333
8	107.6	35.15	69.8	38.339	23.000
9	94.1	34.7	63.05	36.985	22.000

Mean 23.515

It is needleſs to add, that the laſt column marks the denominator of the ſpecific caloric of the metal; the numerator being always 1, and the ſpecific caloric of water being 1. Thus the ſpecific caloric of gold is $\frac{1}{19.712}$. In exactly the ſame manner, and by taking a mean of a number of experiments at different temperatures, did Mr Wilcke aſcertain the ſpecific caloric of a number of other bodies.*

5. With the ſame view, to aſcertain the ſpecific caloric of bodies, a ſimple and ingenious apparatus was contrived by Lavoiſier and La Place. This inſtrument is called a *calorimeter*, or meaſurer of heat. Its principles and conſtruction are the following:

264
Lavoiſier's method.

"If, after having cooled, ſays Lavoiſier, any body to the freezing point, it be expoſed in an atmoſphere of 88.25° the body will gradually become heated, from the ſurface inwards, till at laſt it acquire the ſame temperature with the ſurrounding air. But, if a piece of ice be placed in the ſame ſituation, the circumſtances are quite different; it does not approach in the ſmalleſt degree towards the temperature of the circumambient air, but remains conſtantly at 32°, or the temperature of melting ice, till the laſt portion of ice be completely melted.

"This phenomenon is readily explained; as, to melt ice, or reduce it to water, it requires to be combined with a certain portion of caloric, the whole caloric attracted from the ſurrounding bodies, is arreſted or fixed at the ſurface or external layer of ice which it is employed to diſſolve, and combines with it to form water; the next quantity of caloric combines with the ſecond layer to diſſolve it into water, and ſo on ſucceſſively till the whole ice be diſſolved, or converted into water, by combination with caloric; the very laſt atom ſtill remaining at its former temperature, becauſe the caloric could never penetrate ſo far, while any intermediate ice remained to melt, or to combine with.

"Upon theſe principles, if we conceive a hollow ſphere of ice at the temperature of 32° placed in an atmoſphere of 54.5°, and containing a ſubſtance at any degree of temperature above freezing; it follows, That the heat of the external atmoſphere cannot penetrate into the internal hollow of the ſphere of ice; and, That the heat of the body which is placed in the hollow of the ſphere cannot penetrate outwards beyond it, but will be ſtopped at the internal ſurface, being continually employed to melt ſucceſſive layers of ice, until the temperature of the body be reduced to 32° by having all its ſuperabundant caloric above that temperature carried off to melt the ice. If the whole water, formed within the ſphere of ice during the reduction of the temperature of the included body to 32°, be carefully collected, the weight of the water will be exactly proportional to the quantity of caloric loſt by the body, in paſſing from its original temperature to that of melting ice; for it is evident that a double quantity of caloric would have melted twice the quantity of ice. Hence the quantity of ice melted is a very exact meaſure of the proportional quantity of caloric employed to produce that effect, and conſequently of the quantity loſt by the only ſubſtance that could poſſibly have ſupplied it.

"I have made this ſuppoſition, of what would take place in a hollow ſphere of ice, for the purpoſe of more readily explaining the method uſed in this ſpecies of experiment, which was firſt conceived by M. de la Place,

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* *Thomſon's Chemiſtry*, v. i. 314.

Place. It would be difficult to procure ſuch ſpheres of ice, and inconvenient to make uſe of them when got; but, by means of the following apparatus, we have remedied that defect.

265 Apparatus deſcribed.

"The calorimeter is repreſented in Plate CXLII. fig. 2. The capacity or cavity is divided into three parts, which, for better diſtinction, I ſhall name the interior, middle, and external cavities. The interior cavity *ffff*, into which the ſubſtances ſubmitted to experiment are put, is compoſed of a grating or cage of iron wire, ſupported by ſeveral iron bars; its opening or mouth LM, is covered by the lid HG, fig. 3. which is compoſed of the ſame materials. The middle cavity *bbbb*, fig. 2. contains the ice which ſurrounds the interior cavity, and which is intended to be melted by the caloric of the ſubſtances employed in the experiment. The ice is ſupported by the grate *mm* at the bottom of the cavity, under which is placed the ſieve *nn*.

"In proportion as the ice contained in the middle cavity is melted, by the caloric diſengaged from the body placed in the interior cavity, the water runs through the grate and ſieve, and falls through the conical funnel *ccd*, fig. 2. and the tube *xy*, into a receiver. This water may be retained or let out at pleaſure, by means of the ſtop-cock *u*. The external cavity *aaaa*, fig. 2. is filled with ice, to prevent any effect upon the ice in the middle cavity from the heat of the ſurrounding air, and the water produced from it is carried off through the pipe ST, which ſhuts by means of the ſtop-cock *r*. The whole machine is covered by a lid made of tin, and painted with oil colour, to prevent ruſt.

"When this machine is employed, the middle cavity *bbbb*, fig. 2. and the lid GH, fig. 3. of the interior cavity, the external cavity *aaaa*, fig. 2. and the lid which covers the whole, are all filled with pounded ice, well rammed, ſo that no void ſpaces remain, and the ice of the middle cavity is allowed to drain. The machine is then opened, and the ſubſtance ſubmitted to experiment being placed in the interior cavity, it is inſtantly cloſed. After waiting till the included body is completely cooled to the freezing point, and the whole melted ice has drained from the middle cavity, the water collected in the receiver is accurately weighed. The weight of the water produced during the experiment is an exact meaſure of the caloric diſengaged during the cooling of the included body, as this ſubſtance is evidently in a ſimilar ſituation with the one formerly mentioned as included in a hollow ſphere of ice. The whole caloric diſengaged from the included body is ſtopped by the ice in the middle cavity, and that ice is preſerved from being affected by any other heat by means of the ice contained in the cover and in the external cavity. Experiments of this kind generally laſt from 15 to 20 hours, but they are ſometimes accelerated by covering up the ſubſtance in the interior cavity with well drained ice, which haſtens its cooling.

"It is abſolutely requiſite that there be no communication between the external and middle cavities of the calorimeter, otherwiſe the ice melted by the influence of the ſurrounding air, in the external cavity, would mix with the water produced from the ice of the middle cavity, which would no longer be a meaſure of the caloric loſt by the ſubſtance ſubmitted to experiment.

"When the temperature of the atmoſphere is only a few degrees above the freezing point, its heat can hardly reach the middle cavity, being arreſted by the ice of the cover, and of the external cavity; but, if the temperature of the air be under the degree of freezing, it might cool the ice contained in the middle cavity, by cauſing the ice in the external cavity to fall, in the firſt place, below 32°. It is therefore eſſential that this experiment be carried on in a temperature ſomewhat above freezing: Hence, in time of froſt, the calorimeter muſt be kept in an apartment carefully heated. It is likewiſe neceſſary that the ice employed be not under 32°, for which purpoſe it muſt be pounded, and ſpread out thin for ſome time, in a place where the temperature is higher.

Elem. Clem.

6. Tables of the ſpecific caloric of bodies have been given by Dr Crawford, Mr Kirwan, Bergman, Gadolin, and Meyer. The following are the reſults of their inveſtigations.

TABLE *of the Specific Caloric of various Bodies, that of Water being* = 1.0000.

Bodies.	Specific Gravity.	Specific Caloric.
I. GASES.		
Hydrogen gas	0.000094	21.4000
Oxygen gas	0.0034	4.7490
Common air	0.00122	1.7900
Carbonic acid gas	0.00183	1.0459
Steam		1.5500
Azotic gas	0.00120	0.7036
II. LIQUIDS.		
Water	1.0000	1.0000
Carbonate of ammonia		1.851
Arterial blood		1.030
Cows milk	1.0324	0.9999
Sulphuret of ammonia	0.818	0.9940
Venous blood		0.8928
Solution of brown ſugar		0.8600
Nitric acid		0.844
Sulphate of magneſia 1 Water 8		0.844
Common ſalt 1 Water 8		0.832
Nitre 1 Water 8		0.8167
Muriate of ammonia 1 Water		0.779
Tartar 1 Water 237.3		0.765
Solution of potaſh	1.346	0.759
Sulphate of iron 1 Water 2.5		0.734
Sulphate of ſoda 1 Water 2.9		0.728
Oil of olives	0.9153	0.710
Ammonia	0.997	0.7080

Table Continued.

Bodies.	Specific Gravity.	Specific Caloric.
Muriatic acid	1.122	0.6800
Sulphuric acid 4 Water 5		0.6631
Alum 1 Water 4.45		0.649
Nitric acid 9⅓ Lime 1		0.6181
Nitre 1 Water 3		0.646
Alcohol	0.8371	0.6021
Sulphuric acid	1.840	0.5968
Nitrous acid	1.355	0.576
Linſeed oil	0.9403	0.528
Spermaceti oil		0.5000
Oil of turpentine	0.9910	0.472
Vinegar		0.3870
Lime 9 Water 16		0.3346
Mercury	13.568	0.3100
Diſtilled vinegar		0.1030
III. SOLIDS.		
Ice		0.9000
Ox-hide with the hair		0.787
Lungs of a ſheep		0.769
Lean of ox-beef		0.7400
Pine	0.408	0.65
Fir	0.447	0.60
Lime	0.408	0.62
Pitch-pine	0.495	0.58
Apple tree	0.639	0.57
Alder	0.484	0.53
Oak	0.531	0.51
Aſh	0.631	0.51
Crab-apple	0.603	0.50
Rice		0.5050
Horſe beans		0.5020
Duſt of the pine tree		0.5000
Peaſe		0.4920
Beech	0.692	0.49
Hornbeam	0.690	0.48
Birch	0.608	0.48
Wheat		0.4770
Elm	0.646	0.47
Female oak	0.668	0.45
Plum tree	0.687	0.44
Ebony	1.054	0.43
Barley		0.4210
Oats		0.4160
Pitcoal		0.2777
Charcoal		0.2631
Chalk		0.2564
Ruſt of iron		0.2500
White oxide of antimony waſhed		0.2270
Oxide of copper nearly freed from air		0.2272
Quicklime		0.2199

Table Continued.

Bodies.	Specific Gravity.	Specific Caloric.
Stoneware		0.195
Agate	2.648	0.195
Cryſtal	3.189 ?	0.1929
Cinders		0.1923
Swediſh glaſs	2.386	0.187
Aſhes of cinders		0.1885
Sulphur	1.99	0.183
Flint glaſs	3.3293	0.174
Ruſt of iron nearly freed from air		0.1666
White oxide of antimony ditto		0.1666
Aſhes of the elm		0.1402
Oxide of zinc nearly free from air		0.1369
Iron	7.876	0.1264
Braſs	8.358	0.1141
Copper	8.784	0.1121
Sheet iron		0.1099
Oxide of lead and tin		0.102
Gun-metal		0.1100
White oxide of tin nearly free from air		0.0990
Zinc	7.154	0.0981
Aſhes of charcoal		0.0909
Silver	10.001	0.082
Yellow oxide of lead nearly freed from air		0.0680
Tin	7.380	0.0661
Antimony	6.107	0.0637
Gold	19.040	0.050
Lead	11.456	0.0424
Biſmuth	9.861	0.043

2. Of the ABSOLUTE QUANTITY of CALORIC.

1. Such then are the different methods which have deen propoſed, to aſcertain the relative quantities of caloric which are neceſſary to reduce bodies to the ſame temperature. Attempts have alſo been made to diſcover the temperature of abſolute privation, and thus to aſcertain the whole quantity of caloric which a body contains.

266 Dr Irvine's method.

The firſt attempt made with this view, was by the late Dr Irvine of Glaſgow. The theorem which he invented to aſcertain the real zero, or the abſolute quantity of caloric which a body contains, is founded on the uniformity of the ſpecific caloric of bodies at all temperatures. And taking it for granted that the ſpecific caloric of bodies is always the ſame whatever be the temperature, the whole quantity, or the abſolute quantity, will be proportional to the ſpecific caloric. Having diſcovered the ratio between the abſolute calorics of bodies, and the difference between two abſolute calorics, the whole quantity in any body might be found by calculation. But either the data on which the theorem proceeds are wrong, or the experiments which have been made with the view of applying it to the

267 founded on the uniformity of ſpecific caloric.

268 Reſults very different.

the eſtimation of the abſolute quantity of caloric have been very inaccurately conducted, the reſults varying ſo much from each other. According to Dr Irvine's own experiments and calculation, the real zero with regard to ice would be 1228° below 0°; but according to Dr Crawford's it is 1500°. Mr Kirwan makes it 1318° below 0° in a compariſon of the ſpecific caloric of water and ice. Lavoiſier and La Place fix it at 3426° below 0°, from the reſult of experiments on a mixture of water and quicklime. But in other experiments by the ſame philoſophers, there is a great variation in the reſult. Four parts of ſulphuric acid, and three parts of water, mixed together, give a reſult for the real zero equal to 7260° below 0°; and four parts of ſulphuric acid, and five of water, give it only equal to 2598° below 0°. Profeſſor Robiſon, ſpeaking of the ſpecific and abſolute quantities of heat in bodies being ſuppoſed to be proportional, obſerves that "this opinion is juſt, only on the ſuppoſition that the meaſures, obtained by experiments and calculation, are conſtantly the ſame, whatever the temperatures may be in which the experiments are made. Dr Irvine's ingenious method of diſcovering the temperature of abſolute privation, evidently preſuppoſes this conſtancy of ſpecific heat; or, if they are not conſtant, it ſuppoſes that we know the whole law of variation. Now both of theſe aſſumptions are highly improbable. In none of the progreſſions of natural operations that we are acquainted with do we find this conſtancy. It is much more analogous to other phenomena, to ſuppoſe that, in the temperatures near to that of abſolute privation, the quantities of heat neceſſary for producing equal elevation gradually diminiſh, and this, perhaps, without end, like the diſtance of the hyperbola from its aſſymptote. It is equally probable that the law of diminution may be different in different ſubſtances. This will cauſe the meaſures of ſpecific heats to change their proportions continually; and therefore the ſpecific capacities obſerved in temperatures, all of which are far removed from that of the entire abſence of heat, give us no means of obtaining the proportions of the accumulated ſum of all the heats which have been received into the ſubſtances. It follows from this, that even although it ſhould be granted to Dr Irvine, that the heat which emerges, in mixing vitriolic acid and water, or in the freezing of water, is the difference between the abſolute heat of the mixture, or the ice, and the abſolute heats of the ſubſtances before mixture, or of the water before freezing, ſtill we cannot aſcertain thoſe abſolute heats, or the temperature of no heat.

Accordingly, it appears that it has been only in a very few caſes that Dr Irvine found a tolerable coincidence of his determination of this extreme cold; and the determination by means of mixtures differed enormouſly from thoſe obtained by means of congelation; and ſtill more from thoſe obtained by means of the condenſation of vapour *."

269 Mr Dalton's method.

2. Mr Dalton has propoſed another hypotheſis for determining the real zero, or the abſolute quantity of caloric in bodies. He obſerves that the remarkable fact of the quantity of expanſion of elaſtic fluids being the ſame in the ſame circumſtances, ſhews, that it depends ſolely upon heat: "whereas the expanſion in ſolid and liquid bodies ſeems to depend upon an adjuſtment of the two oppoſite forces of heat and chemical affinity, the one a *conſtant* force in the ſame temperature, the other a *variable* one, according to the nature of the body; hence the unequal expanſion of ſuch bodies. It ſeems therefore that general laws reſpecting the abſolute quantity and the nature of heat, are more likely to be derived from elaſtic fluids than from other ſubſtances.

In order to explain the manner in which elaſtic fluids expand by heat, let us aſſume an hypotheſis that the repulſive force of each particle is exactly proportional to the whole quantity of heat combined with it, or in other words to its temperature reckoned from the point of total privation: then, ſince the diameter of each particle's ſphere of influence is as the cube root of the ſpace occupied by the maſs, we ſhall have $\sqrt[3]{1000} : \sqrt[3]{1235}$ (10 : 11, nearly) : : the abſolute quantity of heat in air of 55°: the abſolute quantity in air of 212°. This gives the point of total privation of heat, or abſolute cold, at 1547° below the point at which water freezes. Dr Crawford deduces the ſaid point, by a method wholly different, to be 1532°. So near a coincidence is certainly more than fortuitous.

The only objection I ſee to this hypotheſis is, that it neceſſarily requires the augmentation of elaſtic fluids for a given quantity of heat to be greater in the higher temperatures than in the lower, becauſe the cubes of a ſeries of numbers in arithmetical progreſſion differ more the larger the numbers or roots: but it has juſt been ſhew that in fact an augmentation of a contrary kind is obſerved. This refers us to the conſideration whether the mercurial thermometer is an accurate meaſure of the increments of heat: if it be, the hypotheſis fails; but if equal increments of heat cauſe a greater expanſion in mercury in the higher than in the lower temperatures, and that in a ſmall degree, the fact noticed above, inſtead of being an objection, will corroborate the hypotheſis. Dr Crawford determines the expanſions of mercury to be very nearly in proportion to the increments of heat: M. de Luc makes them to be leſs for a given quantity of heat in the lower than in the higher part of the ſcale; and in a ratio that agrees with this hypotheſis. Now as every other liquid we are acquainted with is found to expand more in the higher than in the lower temperatures; analogy is in favour of the concluſions of De Luc, that mercury does the ſame." *Manch. Mem.* v. 602.

The different methods which have been propoſed by philoſophers to determine the real zero, or the abſolute quantity of caloric in bodies, and the want of coincidence between the reſults of the experiments and calculations, founded on theſe methods, ſhew us at leaſt, that the ſubject is attended with great difficulty and uncertainty. Perhaps the preſent ſtate of our knowledge does not furniſh us with the means of removing the difficulty. Some fortunate diſcovery is ſtill needed, to guide our ſteps in the ſolution of this problem.

270 Cold.

3. Having thus conſidered the relative and abſolute quantities of caloric in bodies, and the methods which have been propoſed for aſcertaining theſe quantities, it may be neceſſary to ſtate in what ſenſe, or with what limitations, the term *cold* is to be employed. When we leave a room at the temperature of 60°, and go into the air in a froſty day at the temperature of

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* *Black's Lect.* v. i. p. 508.

32°, we ſay that it is cold; or when the hand is held in water at the temperature of 100° for a few minutes, and then ſuddenly plunged into water at the temperature of 40°, the latter is ſaid to be cold. This, however, is merely an expreſſion of the ſenſation excited in the body, which depends ſolely on the abſtraction of its heat. This may be proved by the following experiment. If three quantities of water are taken, the firſt at the temperature of 32°, the ſecond at the temperature of 50°, and the third at the temperature of 100°. Immerſe the right hand into the water at the temperature of 100°, and the left into the water at the temperature of 32°. Let them remain for a minute, and then ſuddenly plunge both hands into the water at the imtermediate temperature of 50°; the right hand will feel cold, and the left hand warm; and thus different ſenſations are produced by the ſame body at the ſame time and at the ſame temperature. But this depends entirely on the previous ſtate of the hands, and on the abſorption or abſtraction of caloric; and this ſeeming paradox is eaſily explained by what has been ſaid on the equal diſtribution of caloric. The right hand which was placed in the water at the temperature of 100° abſorbed caloric, becauſe the temperature of the water is above that of the body. This excites the ſenſation of heat; but when the ſame hand is placed in the water at the temperature of 50° it is deprived of caloric, becauſe the ſurrounding medium is far below its temperature; and thus the ſenſation of cold is produced. But from the left hand, placed in the water at 32° caloric is abſtracted, which gives the ſenſation of cold, and the ſame hand placed in the water at 50° recives caloric, and this entering the body, excites the ſenſation of heat.

Thus then, the term *cold* is merely expreſſive of the relative temperature of two bodies. In common language the word *cold* is ſufficiently intelligible; but in the preſent view of the doctrine of caloric, it can have no other preciſe meaning, than to expreſs the abſence of a quantity of heat.

Obſerving the remarkable effects which were produced on fluids by the abſtraction of caloric, it is not at all ſurpriſing that the phenomena which were not obſerved with great accuracy, ſhould be aſcribed rather to the addition of ſome new body, than to the abſtraction of one which was formerly in combination.

271 Frigorific particles.

Hence originated the hypotheſis which ſuppoſed the exiſtence of the frigorific particles of Le Mairan and Muſchenbroeck, which prevailed till the effects of caloric were developed by the diſcoveries of modern chemiſtry. They were led to this hypotheſis of the entrance of extraneous matter into water when it is converted from the fluid into the ſolid ſtate, from obſerving the increaſe of bulk which takes place. Theſe frigorific particles, to which all the effects of cold were aſcribed, it was imagined, had ſome reſemblance to nitre. This opinion probably aroſe from the circumſtance of a great degree of cold, or diminution of temperature, being produced by diſſolving nitre in water. The frigorific particles were ſuppoſed to be conſtantly floating in the air, and by mixing with liquid bodies, as water, converted them into ſolids, by acting the part of wedges, which prevented the free motion of the particles among each other.

272 Cold ſeems to be reflected.

The experiments of Profeſſor Pictet, in which cold ſeems to be reflected, ſtill give ſome ſupport to this opinion. Two concave mirrors of tin were placed at the diſtance of 10½ feet from each other; a glaſs veſſel full of ſnow was placed in the focus of the one, and an air thermometer in that of the other. The thermometer ſunk ſeveral degrees, but when the ſnow was removed, it roſe again; and when a greater degree of cold was produced on the ſnow, by pouring an acid upon it which diſſolved it rapidly, the thermometer fell ſeveral degrees lower. At firſt ſight it appears, that cold has been given out by the ſnow, and this cold reflected by the mirrors occaſioned the fall of the thermometer. The explanation of this fact is not without difficulty.

273 Accounted for.

As the rays of caloric are emitted by all ſurrounding bodies, the temperature of the thermometer is probably kept up by ſome of theſe rays. Suppoſe when the thermometer is placed in the focus of one of the mirrors, that it ſtands at the ſame temperature that it would do when brought into contact with any other of the ſurrounding bodies; and that this temperature is partly owing to the rays of caloric which are paſſing off from thoſe bodies: if then there is any interruption of theſe rays, the temperature of that body, as the thermometer, muſt be diminiſhed. This is probably what takes place when the temperature of the thermometer in the focus of one of the mirrors falls, by placing a cold body in the focus of the other. To make this a little plainer, ſuppoſe the temperature of the thermometer is kept up by 100 rays of caloric; when a cold body is placed in a proper ſituation, as in the focus of the oppoſite mirror; if any number of theſe rays be abſorbed by the cold body, it muſt conſequently fall in temperature.

But although the explanation be not altogether ſatisfactory, it affords no proof of the exiſtence of frigorific particles. Were we even to admit this hypotheſis, it would not probably aſſiſt us much in the explanation.

274 To produce great cold.

4. Great degrees of cold are produced, by mixing together thoſe ſubſtances which diſſolve rapidly. The reaſon of this will appear by recollecting what has been ſaid of the abſorption of caloric when a ſolid body is converted into a fluid. Mixtures to produce artificial cold, are generally made of the neutral ſalts diſſolved in water; of diluted acids and ſome of the neutral ſalts; and of ſnow or pounded ice with ſome of theſe ſalts. A great number of experiments were made upon this ſubject by Mr Walker *; alſo by Profeſſor Lowitz of Peterſburgh †; by Fourcroy and Vauquelin ‡; and by Guyton §. The following table exhibits the reſults of theſe experiments.

TABLE of Freezing Mixtures.

	Mixtures.	Parts.	Thermometer ſinks.
1.	Muriate of ammonia	5	From 50° to 10°
	Nitre	5	
	Water	16	
2.	Muriate of ammonia	5	From 50° to 4°
	Nitre	5	
	Sulphate of ſoda	8	
	Water	16	

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* *Phil. Tranſ.* 1795, p. 270. 1801, p. 120.

† *Ann. de Chim.* vol. xxvi. p. 297.

‡ *Ibid.* vol. xxix. p. 281.

§ *Ibid.* 290.

Table of Freezing Mixtures continued.

	Mixtures.	Parts.	Thermometer ſinks.
3.	Nitrate of ammonia Water	1 1	From 50° to 4°
4.	Nitrate of ammonia Carbonate of ſoda Water	1 1 1	From 50° to 7°
5.	Sulphate of ſoda Diluted nitric acid	3 2	From 50° to 3°
6.	Sulphate of ſoda Muriate of ammonia Nitre Diluted nitric acid	6 4 2 4	From 50° to 10°
7.	Sulphate of ſoda Nitrate of ammonia Diluted nitric acid	6 5 4	From 50° to 14°
8.	Phoſphate of ſoda Diluted nitric acid	9 4	From 50° to 12°
9.	Phoſphate of ſoda Nitrate of ammonia Diluted nitric acid	9 6 4	From 50° to 21°
10.	Sulphate of ſoda Muriatic acid	8 5	From 50° to 0°
11.	Sulphate of ſoda Diluted ſulphuric acid	5 4	From 50° to 3°
12.	Snow Common ſalt	1 1	From 52° to 0°
13.	Snow or pounded ice Common ſalt	2 1	From 0° to —5°
14.	Snow or pounded ice Common ſalt Muriate of ammonia and nitre	1 5 5	From —5° to —18°
15.	Snow or pounded ice Common ſalt Nitrate of ammonia	12 5 5	From —18° to —25°
16.	Snow and diluted nitric acid.		From 0° to —46°
17.	Potaſh Snow	4 3	From 32° to — 51°
18.	Snow Diluted ſulphuric acid Diluted nitric acid	2 1 1	From —10° to —56°
19.	Snow Diluted ſulphuric acid	1 1	From 20° to —60°
20.	Muriate of lime Snow	3 2	From 32° to —50°
21.	Muriate of lime Snow	2 1	From 0° to —66°
22.	Muriate of lime Snow	3 1	From —40° to —73°
23.	Diluted ſulphuric acid Snow	10 8	From —68° to —91°

275 How to uſe the freezing mixtures. When any of theſe ſubſtances are to be employed as freezing mixtures, the ſalts ſhould be uſed freſh cryſtallized, and reduced to fine powder: and it will perhaps be found moſt convenient to obſerve the proportions which are ſet down in the table. Suppoſe it is wanted to produce a degree of artificial cold equal to —50°, which is the temperature produced from 32° by the 20th freezing mixture. The ſubſtances employed, namely, the muriate of lime and the ſnow, muſt be previouſly cooled down to the temperature of 32°, or any degree below it. This may be done by placing them ſeparately in the 11th freezing mixture, the ſulphate of ſoda and diluted ſulphuric acid, which reduces the temperature from 50° to 3°; or in the 12th freezing mixture of ſnow and common ſalt, which reduces the temperature from 32° to 0. The materials thus cooled down, are then to be mixed together as quickly as poſſible, when, if the experiment ſucceed, the temperature will fall from 32° to —50°, as in the 20th freezing mixture. 276 Veſſels. The veſſels which are employed for theſe proceſſes ſhould be very thin, and made of the beſt conductors of heat. Veſſels of tin plate anſwer the purpoſe, and when acids are to be uſed, they may be lined with wax, which will ſecure them ſufficiently againſt their action. They ſhould be of no larger dimenſions than juſt to contain the materials.

SECT. VI. *Of the Sources of Caloric.*

We are now to conſider the means by which caloric may be evolved, or rendered ſenſible. This is a ſubject of great importance, both as a curious inveſtigation, and as a uſeful and neceſſary application in chemiſtry and the arts of life. According to the different ſources from which caloric is derived, or the means which are employed for its evolution, theſe may be reckoned five in number; namely, percuſſion, friction, mixture, the ſun, combuſtion: and we ſhall conſider them in the order in which they have been named.

Firſt Source of Caloric,

Percuſſion.

277 Flint and ſteel. The production of heat by ſtriking together flint and ſteel, is a well known fact. The ſame thing alſo takes place when many other hard bodies are ſtruck againſt each other. Fires are frequently kindled by making a piece of iron red-hot by percuſſion, which is effected by ſtriking it ſmartly with a hammer. 278 Heat produced owing to condenſation. In moſt of the caſes in which caloric is evolved by percuſſion, this evolution is aſcribed to the condenſation of the particles of the body ſtruck. This has been obſerved to take place, both in elaſtic fluids and liquids.

279 in airs; 1. The ſudden condenſation of air alone, has been found to produce a change of ſeveral degrees in the thermometer. In ſome experiments by Dr Darwin, the condenſed air from an air-gun, thrown on the bulb of a thermometer, uniformly ſunk it about 2°. This ſhews that the condenſed air had given out ſome of its caloric; for during the operation of condenſing it, the apparatus became ſenſibly hot *.

Mr Dalton's experiments on the condenſation and rarefaction of air, ſhew that an increaſe of temperature of 50° is produced, by admitting air into an exhauſted receiver; and when the equilibrium is reſtored to condenſed air, 50° of cold is produced. The ſuddenneſs of the fall and riſe of the thermometer is very remarkable in theſe caſes; and from this circumſtance, Mr Dalton conjectures, that the real change of temperature of the air or medium, was much greater than the thermometer indicated; but that the inequality exiſted only for a few ſeconds †. From theſe experiments, therefore, it appears that caloric is evolved during the condenſation, and abſorbed during the rarefaction or air.

* *Philoſ. Tranſ.* 1789. p. 44.

† *Manch. Mem.* vol. v. p. 515.

A conſiderable riſe in temperature takes place, when different gaſes unite together, and are condenſed. Muriatic acid gas and ammoniacal gas, when combined together, form a ſolid ſalt; and during this combination a great quantity of caloric is evolved.

280 in hard bodies, 2. To the ſame cauſe is aſcribed the caloric which is evolved by the percuſſion of hard bodies. This is particularly the caſe with metallic ſubſtances. They acquire a conſiderable increaſe of denſity by hammering; and during this proceſs caloric is evolved. A piece of iron, it has been obſerved, becomes red-hot when it is ſmartly ſtruck with a hammer on an anvil; and it acquires a conſiderable increaſe of denſity. Before hammering the ſpecific gravity of iron is 7.788; after it is hammered it increaſes to 7.840. In ſome other metals the increaſe of denſity is ſtill more remarkable. Before hammering, platina is only 19.5; and after hammering, its ſpecific gravity is increaſed to 23.0. As a proof that the heat is evolved by condenſation, iron, which has been once heated by hammering, cannot be ſubjected to the ſame proceſs till it has become ſo brittle that it flies to pieces under the ſtrokes of the hammer.

281 Difficult to account for incombuſtibles giving out heat when ſtruck. 3. It is perhaps more difficult to account for the caloric and light which are emitted by incombuſtible ſubſtances; as, for inſtance, in the caſe of two quartz ſtones ſtruck againſt each other, which has been already alluded to in treating of light. The particles of theſe bodies which were ſtruck off by percuſſion, are found, on examination, to be in a ſtate of fuſion; and it would appear that this is a caſe in which light and caloric are emitted without oxygen having any ſhare in the action, as is ſuppoſed to happen in all caſes of combuſtion.

In ſome obſervations on the appearances produced by the colliſion of ſteel with hard bodies, made by Mr Davy, he mentions that Mr Hawkſbee ſhewed *, that no ſparks could be produced *in vacuo*; a faint light was only perceived. Mr Davy thinks that the vivid ſparks obtained from ſteel in the atmoſphere, are owing to the combination of the ſmall abraded and heated metallic particles with oxygen; but it has been doubted, he obſerves, whether the faint luminous appearance, when the experiment is made *in vacuo*, be owing to the light produced by the fracture and abraſion of the particles of the flint, or only partly to this cauſe, and partly to the ignition of the minute filaments ſeparated from the ſteel. When a fine and thin flint, which is eaſily broken, is uſed for the colliſion *in vacuo*, the light is more vivid, than when a thick one is employed. From this he concludes that the particles of ſteel are rendered luminous in conſequence of combuſtion. This opinion was proved by the following experiment.

* *Philoſ. Tranſ.* vol. xxxiv. p. 2165.

A thin piece of iron pyrites (ſulphuret of iron) was inſerted in a gun-lock in place of the flint. By colliſion in the atmoſphere it gave vivid ſparks, chiefly white, but ſometimes mixed with a few red ſparks. The ſame experiment was repeated when the apparatus was introduced into the exhauſted receiver of an air-pump; but no light whatever appeared.

282 Suppoſed to be electric. Mr Davy further obſerves, that bodies which become luminous by being ſtruck or rubbed together *in vacuo*, under water, or in gaſes that do not contain oxygen; ſuch bodies, for inſtance, as fluate and carbonate of lime, ſiliceous ſtones, glaſs, ſugar, and many of the compound ſalts, are both electrics *per ſe* and phoſphoreſcent ſubſtances; ſo that the flaſhes they produce are probably occaſioned, partly by electricity and partly by phoſphoreſcence. In ſome caſes, however, by the colliſion of very hard, ſtony bodies, which are bad conductors of heat, there may be an actual ignition of the particles. This ſeems to be countenanced by various facts. Mr T. Wedgwood found, that a piece of window-glaſs, when brought into contact with a revolving wheel of grit, became red-hot at its point of friction, and gave off luminous particles, which were capable of inflaming gunpowder and hydrogen gas †; and we are informed, Mr Davy adds, by a late voyager (s), that the natives of Oonalaſhka light their fires by ſtriking together two pieces of quartz over dry graſs,

† *Ibid.* 1795. p. 45.

(s) Sauer's account of this fact is the following: " I obſerved in all the huts a baſket containing two large pieces of quartz, a large piece of native ſulphur, and ſome dry graſs or moſs. This ſerves them in kindling fires; for which purpoſe they rub the native ſulphur on the ſtones over the dry graſs, ſtrewed lightly with a few graſs, their ſurfaces being previouſly rubbed with ſulphur *.

* Journ. Roy. Inſt. vol. i. p. 264.

Second Source of Caloric,

Friction.

283 Combuſtible bodies inflamed.

1. A great quantity of caloric is alſo given out by friction. The intenſity of the heat produced by friction depends on many circumſtances, and varies chiefly in the ratio of the time employed and the nature and ſurface of the bodies which are rubbed together. When the bodies rubbed are combuſtible, as two pieces of dry wood, they may be inflamed; but when they poſſeſs combuſtibility in a low degree, or are altogether incombuſtible, the temperature may be raiſed ſo high as to communicate a degree of heat ſufficient to ſet fire to combuſtible bodies. Greater difficulty ſtill attends the explanation of the phenomena of the evolution of caloric by friction than by the percuſſion of hard, incombuſtible bodies. In this caſe there can be no increaſe of denſity by the friction in many inſtances, for caloric is evolved by rubbing together two pieces of wood, or rubbing the hand on a piece of ſoft cloth where increaſe of denſity can ſcarcely be ſuppoſed. 284 Heat by friction not owing to diminiſhed ſpecific caloric. Nor can the increaſe of temperature by friction be accounted for by the diminution of the ſpecific caloric of the bodies which are rubbed together; for Count Rumford, who made ſome intereſting experiments on this ſubject, could not diſcover any change in this reſpect, and ſuppoſing that this change had taken place, it would not be ſufficiently great to account for all the heat produced. In one of theſe experiments he took a braſs ſix-pounder, caſt ſolid, and rough as it came from the foundery; fixed it horizontally on the machine fixed for boring, and cauſed its extremity to be cut off; and by turning round the metal in that part, a ſolid cylinder was formed 7¾ inches in diameter, and 9$\frac{8}{10}$ inches long. 285 proved by Count Rumford. This when finiſhed remained joined to the reſt of the metal by a ſmall cylindrical neck 2$\frac{1}{5}$ inches in diameter, and 2$\frac{8}{10}$ inches long. This ſhort cylinder was bored with a horizontal borer uſed in boring cannon. Its bore which was 3$\frac{7}{10}$ inches in diameter, inſtead of being continued through its whole length 9$\frac{8}{10}$ inches, was only 7$\frac{2}{10}$ inches in length. A ſolid bottom of 2$\frac{6}{10}$ inches in length was thus left. A blunt ſteel borer was preſſed againſt the bottom of the bore of the cylinder with a force equal to 10,000 lb. avoirdupois; and the cylinder was turned round by horſes at the rate of about 32 times in a minute. To prevent the diſſipation of the heat, the cylinder was covered up with thick flannel. At the beginning of the experiment the temperature of the air and of the cylinder was 60°. At the end of 30′, when it had made 960 revolutions, a mercurial thermometer was introduced into the hole made to receive it in the ſide of the cylinder, and the mercury roſe to 130°. When the borer was removed, and the metallic duſt or ſcales taken out of the bottom of the cylinder, it was found to amount to 837 grs. As the weight of this duſt amounts to no more than $\frac{1}{948}$th part of that of the cylinder, it muſt have given off 948° to raiſe the temperature of the cylinder 1°, and conſequently it muſt have given out 66,360° of heat in the courſe of the experiment.

286 Nor to the air.

2. But to determine whether the air of the atmoſphere had any part or not in the generation of this heat, by one deciſive experiment, he contrived the following, in which it was impoſſible for it to produce any effect whatever. The apparatus was incloſed in a wooden box, which was made water-tight, and being filled with water, completely excluded the external air. The quantity of water employed was 18.77 lb. avoirdupois or 2¼ wine gallons, and the temperature at the commencement of the experiment was 60°. The machine was put in motion, and moved at the ſame rate as in the former experiment. At the end of an hour the temperature was 107°; in half an hour more, it roſe to 178°, and at the end of two hours and 30′ from the beginning of the experiment the water actually boiled. By Count Rumford's calculation the caloric generated by friction in this experiment, and accumulated in two hours and 30′, would have heated ice-cold water 180°, or cauſed it to boil. From the reſults of his computation it appears, that the quantity of caloric thus generated equably, was greater than that produced equably in the combuſtion of nine wax-candles, each ¾ of an inch in diameter, burning with clear bright flames for the ſame length of time.

287 Count Rumford concludes that heat is motion.

Reflecting on theſe experiments, Count Rumford recurs to the queſtion, What is heat? Is there any ſuch thing as an igneous fluid? And after ſtating that the quantity of caloric thus generated could neither be furniſhed by the particles of the metal, detached from the ſolid maſſes, nor by the air, nor by the water, becauſe it muſt have received its heat from the apparatus, he concludes, that caloric is not a material ſubſtance, but only a peculiar kind of motion produced among the particles of matter †.

† Phil. Tranſ. 1798, p. 80.

288 Nor to combination with oxygen.

3. The experiments of Profeſſor Pictet alſo prove, that the caloric generated by friction is not owing to the combination of oxygen with any of the bodies. He contrived an apparatus which could be introduced into the receiver of an air-pump. By means of this apparatus, a piece of adamantine ſpar was rubbed againſt a ſteel cup in the open air. A thermometer which was fixed in the inſide of the cup, did not riſe when the apparatus was ſet in motion, although abundance of ſparks were produced. When the apparatus was placed in an exhauſted receiver, and the experiment repeated, a phoſphoric light, but no ſparks, appeared, nor was the thermometer any way affected; but when a ſmaller braſs cup was employed, and a piece of braſs rubbed againſt it in the open air, the thermometer was not affected till the motion ceaſed, and then it roſe 0.3°. The caloric, it would appear, was carried off as it was generated, by the motion of the air. When the ſame experiment was repeated in

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few feathers in the top where the ſulphur falls; then they ſtrike the two ſtones one againſt the other; the fine particles of ſulphur immediately blaze like a flaſh of lightning, and communicating with the ſtraw ſet the whole in a flame. *Sauer's account of Billings's Expedition to the northern parts of Ruſſia*, p 159.

in vacuo, the thermometer roſe 1.2°, and it began to riſe as ſoon as the friction commenced. When a piece of wood was made to rub on a wooden cup, the thermometer roſe 2.1°, and *in vacuo* 2.4° †.

289
Probably owing to electricity.

Theſe experiments, therefore, are ſufficiently concluſive to prove that the caloric evolved by friction is not derived from the atmoſphere; but ſtill the queſtion recurs, What is its origin? No ſatisfactory anſwer can be given to this queſtion, if it cannot be reſolved, as ſome have ſuppoſed, by having recourſe to the agency of electricity; and, conſidering the ſimilarity of the effects of caloric and electricity in heating and cooling bodies, in producing the expanſion and fuſion of metallic ſubſtances, in effecting the actual combuſtion of inflammable matters, and that in other reſpects the one can be ſubſtituted for the other, it is not at all improbable that electric matter, which is generated in great abundance by friction, may be the chief agent in the evolution of caloric by the friction of bodies on each other.

290
Choice of wood in machines important on account of the friction.

4. In ſome obſervations on ſpontaneous inflammations by Bartholdi, he mentions the experiments which were repeated by D. Palcani, for obtaining fire by the friction of two pieces of wood, in which he gave to one of the rubbing pieces the form of a tablet, and to the other that of a ſpindle or cylinder; and as the reſults of ſome of theſe experiments are of importance to ſhew what attention ought to be paid to the choice of wood, in the conſtruction of machines and inſtruments where there is conſiderable friction, we ſhall ſtate the following.

Cylinders.	Tablet.	Duration.	Effect.
Boxwood,	Box,	5′	Senſible heat.
do.	Poplar,	5	do.
do.	Oak,	5	do.
do.	Mulberry,	3	Conſiderable heat and ſmoke,
do.	Laurel,	3	do.
Laurel,	Poplar,	2	do.
do.	Ivy,	2	do.
Ivy,	Box,	3	do.
do.	Walnut,	3	do.
Olive,	Olive,	3	do.
Mulberry,	Laurel,	2	Conſiderable heat, ſmoke, and blackneſs.
Aſh,	Oak,	5	Senſible heat.
do.	Fir,	5	do.
Peartree,	Oak,	5	do.
Cherry,	Elm,	5	do.
Plumtree,	Appletree,	5	do.
Oak,	Fir,	5	do.

When the experiment was changed, and a cylinder of one of the kinds of wood was rubbed between two tablets of the other; as for example, a cylinder of poplar between two tablets of mulberry wood, the increaſe of the rubbed ſurfaces which were in contact with the air, produced a temperature much more conſiderable; and almoſt the whole of the kinds of wood enumerated above, took fire.

The effect of friction alſo varies according as the woods employed of the ſame kind are rubbed in the direction of the fibres, or when the fibres croſs each other. In the firſt caſe the friction and heat generated are much more conſiderable than in the ſecond †.

Third Source of Caloric,

Mixture.

291
Change of temperature by combination.

1. It is one of the characteriſtics of chemical action to produce a change of temperature. This happens in conſequence of the increaſe or diminution of bulk of the bodies which have been the ſubject of combination, or a total change of their ſtate and properties. Thus it has been eſtabliſhed as a general law in chemical ſcience, that all bodies which paſs from the ſolid to the fluid ſtate, abſorb a quantity of caloric: and all bodies which paſs from the fluid to the ſolid ſtate, give out caloric. This law, therefore, will enable us to account for thoſe changes which take place by the mixture of different bodies. In the courſe of the detail of chemical ſcience on which we are about to enter, we ſhall have frequent opportunities of pointing out the effects of this law. At preſent we ſhall only mention a few inſtances in which caloric is evolved by mixture, or chemical action.

292
Gaſeous bodies forming ſolids or liquids.

2. When two ſubſtances in the ſtate of gas enter into union, and form a ſolid or liquid body, caloric is evolved.

a. Ammoniacal gas and muriatic acid gas, when they are mixed together, inſtantly combine, and form a ſolid ſalt, at the ſame time giving out a quantity of caloric.

b. When oxygen gas and nitrous gas are mixed together, they combine and form a liquid, and at the moment of union, give out caloric.

3. When two liquids are mixed together, and if the denſity of the mixture be greater than the mean of the two liquids, caloric is evolved during the combination.

a. When alcohol or ſpirits of wine and water are mixed together, the denſity is greater than the mean of the two liquids; caloric therefore is given out during the mixture.

b. A much greater degree of heat is produced by mixing together ſulphuric acid and water. If four parts of ſulphuric acid be combined with one part of water, the denſity of the mixture is much greater than the medium denſity of the two liquids, and accordingly the quantity of caloric evolved is ſufficient to boil water.

4. A great quantity of caloric is alſo given out when a fluid body combines with a ſolid. We have an inſtance of this in the ſlacking of lime.

a. When water is thrown upon quicklime, it inſtantly diſappears; for part of it combines with the lime, and becomes ſolid; and thus paſſing from the liquid to the ſolid ſtate, it gives out caloric.

b. If a quantity of ſulphuric acid be poured upon quicklime, the caloric evolved is ſufficient to raiſe part of the ſulphuric acid into vapour.

293
Cold produced by water becoming ſuddenly fluid.

5. Were we to reverſe theſe experiments, and ſtate inſtances of caloric being abſorbed during the mixture of bodies, we ſhould obſerve the operation of the ſame law, in the caſe of ſolid bodies becoming fluid, producing a great degree of cold. But it appears that the production of cold by the ſolution of ſalts in water is owing to the water which is in a previous ſtate

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† *Eſſai ſur le Feu*, chap. ix.

† *Annal de Chim.* vol. xlvii. p. 252.

of combination with one of the ſalts: and thus water paſſing from the ſolid to the liquid ſtate, muſt abſorb caloric, and therefore produce cold. The ſalts which are moſt proper for this purpoſe, contain a great proportion of water in their compoſition; for if the ſame ſalts are deprived of water by expoſing them to heat, the ſame effect by no means follows. On the contrary, when they are diſſolved in water in this ſtate, heat is produced, becauſe they combine with a portion of the water for which they have a ſtrong affinity, and this water paſſing from the liquid to the ſolid ſtate, gives out its caloric.

294 Heat evolved in fermentation, &c.

6. A conſiderable quantity of caloric is alſo generated in other mixtures, in which the fermentation and putrefaction of animal and vegetable ſubſtances takes place. During theſe proceſſes the ſubſtances which are held in ſolution enter into new combinations, and their chemical properties are totally changed. While this change is going on, there is a gradual and conſtant evolution of caloric.

It is an artificial heat of this kind, which is generated by animal and vegetable matters, and on account of its uniformity and conſtancy is employed for promoting vegetation; as when horſe dung and tanner's bark are uſed in making hot beds; or for the hatching of eggs, a practice which has been long in uſe in Egypt.

Fourth Source of Caloric,

The Sun.

295 The ſun an opake body.

1. But the great ſource of light and heat in the planetary ſyſtem is the ſun. When treating of light we mentioned a ſpeculation of philoſophers about the great and conſtant waſte of light, which the ſun, although a body of immenſe magnitude, muſt ſuſtain. But ſince the nature and conſtitution of the ſun were diſcovered by Dr Herſchel, theſe ſpeculations fall to the ground. According to theſe diſcoveries, the ſun is not, as was formerly ſuppoſed, an immenſe globe of fire, in which the materials compoſing it were continually waſting by combuſtion; but a ſolid opaque body, ſimilar to the other planets, and ſurrounded by a very denſe atmoſphere, in which are obſerved two kinds of clouds. The lower region of clouds is ſimilar to thoſe in the atmoſphere of the earth. The uppermoſt region of clouds is luminous, and from this proceed the light and heat which were ſuppoſed to come from the body of the ſun. This luminous region, it appears from Dr Herſchel's obſervations, in conſequence of changes which ſeem to be conſtantly going on in it, exhibits different degrees of ſplendour, diminiſhing greatly the quantity of light and heat which are emitted at other times. To theſe variations he aſcribes the difference of temperature in different ſeaſons, and the conſequent abundance or deficiency of crops.

296 Dark colours abſorb heat.

2. It is a familiar obſervation, that dark-coloured clothes, as black for inſtance, are much warmer than thoſe which are of a lighter colour. The obſervation and the practice founded upon it are correct, although the reaſon is only obvious to the philoſopher. The rays of light, and alſo probably thoſe of caloric, are reflected in greater proportion by white bodies, than by thoſe which are of a deeper colour. The ſun's rays enter the opaque body, and combine with it, and thus increaſe the temperature. Theſe rays are permitted to paſs through tranſparent bodies, which are very little affected by them; but combining with opaque bodies they heat them, and the deeper the colour of the body, the greater is the increaſe of temperature.

297 Hooke and Franklin's experiments.

3. But this has not been left to the uncertainty of common obſervation. Experiments were made by Dr Franklin, and before him by Dr Hooke, to aſcertain this curious point. Pieces of cloth of different colours were placed upon ſnow, and expoſed to the light of the ſun. The colours were white, red, blue, black; and it was found that the darkeſt coloured pieces acquired moſt heat, becauſe they ſunk deepeſt in the ſnow, and this was in proportion to the darkneſs of the colour.

298 Mr Davy's.

Mr Davy made a ſimilar experiment, to determine the correſpondence between the increaſe of repulſive motion in bodies from the action of light and dark colours.

"Six ſimilar pieces of copper, (T) of equal weight, ſize, and denſity, were thus coloured, one white, one yellow, one red, one green, one blue, and one black. A portion of a mixture of oil and wax, which became fluid at about 76°, was placed on the centre of each on the inferior ſide. They were then attached to a board painted white, and ſo placed with regard to the ſun, that their upper ſurfaces were equally expoſed to the light. Their inferior ſurfaces, to which the cerate was attached, were equally deprived of light and heat, that is, they were ſo expoſed, that there could be no miſtake with regard to the repulſive motion generated in them by the action of light. The changes of temperature in them, from the action of light, took place in the following order. The cerate on the black plate began to melt perceptibly before the reſt, the blue next in order, then the green and the red, and laſtly the yellow. The white was ſcarcely at all affected; the black was in a complete ſtate of fuſion *. It appears, therefore, from theſe experiments, that caloric enters bodies in different proportions; and in the greateſt proportion in the darkeſt coloured bodies.

* *Beddoes' Contributions*, p. 44.

299 Bodies which abſorb moſt light become warmeſt.

It appears too, that thoſe bodies which abſorb moſt light, acquire the greateſt degree of temperature when expoſed to the ſun's rays. This has been demonſtrated by the experiments of Wedgwood, Cavallo, and Pictet.

The former took two pieces of phoſphoreſcent marble, one of which was blackened, and placed them on a hot iron. No light appeared from the blackened marble, but the other exhibited its uſual phoſphoreſcence. Upon a ſecond expoſure, the piece which was not blackened gave a faint light; the blackened one, as before, gave none at all. When the black was wiped off, and both pieces were again placed upon the heater, no light appeared either from the one or the other. This experiment ſhows, that the phoſphoreſcent property was nearly deſtroyed without any viſible light having appeared. But both pieces of marble before being heated, muſt have contained the ſame quantity of

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(T) Each an inch ſquare, and two lines thick.

of light and heat, and therefore the light from the blackened piece muſt have been abſorbed by the black colour *.

In Cavallo's experiments (u), the bulb of a thermometer was painted black, and expoſed along with other thermometers to the ſun's rays. The difference of temperature between the blackened thermometer and the other, ſometimes amounted to 10°; that is, the blackened thermometer indicated a temperature 10° higher than the other. But this difference was not conſtant, for it varied according to the brightneſs of the ſun, and the denſity and temperature of the atmoſphere. Conſiderable variations were alſo obſerved from the difference of colours which were employed, and from the difference of poliſh of the ſurface of the plate.

The ſame thing was obſerved when the thermometers were expoſed to ſtrong day light. The thermometer whoſe bulb was blackened indicated the higheſt temperature †.

In an experiment by Profeſſor Pictet, two thermometers, one of which had its bulb blackened, when they were kept in a dark place, indicated the ſame temperature. Theſe experiments prove the cloſe connection between light and caloric; for the greater the proportion of light abſorbed by any body, the higher is the temperature of that body. And when the light is totally excluded, as in the laſt-mentioned experiment of Pictet, the temperature is the ſame ‡.

300
Different heating power of the rays.

4. But it has been ſhown that there is a very great difference in the heating power of the different rays of light. It appears from the experiments of Dr Herſchel, that this heating power increaſes from the middle of the ſpectrum to the red ray, and is greateſt beyond it, where the rays are inviſible. Hence it is inferred that the rays of light and caloric nearly accompany each other, and that the latter are in different proportions in the different coloured rays. They are eaſily ſeparated from each other, as when the ſun's rays are tranſmitted through a tranſparent body, the rays of light paſs on ſeemingly undiminiſhed, but the rays of caloric are intercepted. When the ſun's rays are directed to an opaque body, the rays of light are reflected, and the rays of caloric are abſorbed and retained. This is the caſe with the light of the moon, which, however much it be concentrated, gives no indication of being accompanied with heat.

It has alſo been ſhown, that the different rays of light produce different chemical effects on metallic ſalts and oxides. Theſe effects increaſe on the oppoſite direction of the ſpectrum, from the heating power of the rays. From the middle of the ſpectrum towards the violet end, they become more powerful; and produce the greateſt effect beyond the viſible rays.

301
Solar rays of three kinds.

5. From theſe diſcoveries it appears, that the ſolar rays are of three kinds. 1. Rays which produce heat; 2. Rays which produce colour; and, 3. Rays which deprive metallic ſubſtances of their oxygen. The firſt ſet of rays is in greateſt abundance, or are moſt powerful towards the red end of the ſpectrum, and are leaſt refracted. The ſecond ſet, or thoſe which illuminate objects, are moſt powerful in the middle of the ſpectrum; and the third ſet produce the greateſt effect towards the violet end, where the rays are moſt refracted.

302
Tranſparent bodies not heated by the ſolar rays.

6. The ſolar rays paſs through tranſparent bodies without increaſing their temperature. The atmoſphere, for inſtance, receives no increaſe of temperature by tranſmitting the ſun's rays, till theſe rays are reflected from other bodies, or are communicated to it by bodies which have abſorbed them. This is alſo proved by the ſun's rays being tranſmitted through convex lenſes, producing a high degree of temperature when they are concentrated, but giving no increaſe of temperature to the glaſs itſelf. By this method, the heat which proceeds from the ſun can be greatly increaſed. Indeed, the intenſity of temperature produced in this way is equal to that of the hotteſt furnace. This is done, either by reflecting the ſun's rays from a concave poliſhed mirror, or by concentrating or collecting them by the refractive power of convex lenſes, and directing the rays thus concentrated, on the combuſtible body. See *Burning-Glass*.

Fifth Source of Caloric,

Combuſtion.

303
Effects of combuſtion ſtriking.

It was impoſſible for men whoſe attention was directed to the phenomena of nature, long to let paſs unobſerved the ſingular appearances which are exhibited in the combuſtion or burning of bodies. Indeed the changes produced on bodies by this proceſs, the aſtoniſhing effects which follow, and the importance of the proceſs itſelf, could not fail to excite great intereſt and attention.

304
Important,

305
but of difficult explanation.

As combuſtion is one of the principal ſources of heat, it has long occupied the attention of men in general, both as to the means of its improvement, and application in the arts of life, and in the diſcovery of a theory or explanation which will account for the phenomena. But the want of ſucceſs in this branch of philoſophical inveſtigation, even at the preſent day, ſhews that the ſubject is attended with great difficulty.

306
Difference between increaſe of temperature and burning.

When a piece of iron is expoſed to a high temperature, it becomes red hot, and when it is removed from the heating body, it continues for ſome time to give out light and heat. But when it is ſuffered to cool, it returns to the ſame ſtate in which it was before it was heated, having undergone no perceptible change. When a piece of wood is burnt, it alſo gives out light and heat, but during this proceſs it is totally changed. Great part is diſſipated, and nothing remains but a ſmall quantity of aſhes.

When a piece of ſulphur is expoſed to a temperature between 300° and 400°, it takes fire and burns; gives out heat and light, and during this proceſs the ſulphur has acquired new properties, or has entered into new combinations.

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* *Phil. Tranſ.* 1792. p. 278.

† *Ibid.* 1780, p. 587.

‡ *Eſſai ſur le Feu*, ch. iv.

(u) The hint of theſe experiments, he ſays, was taken from the account of an experiment in a volume of the Philoſophical Tranſactions, made with a thermometer whoſe bulb was painted black, and expoſed to the rays of the ſun. The experiment alluded to was made by Dr Watſon, biſhop of Landaff. *Philoſophical Tranſactions*, 1763, p. 40.

307 Bodies totally changed by combuſtion.

When a metallic ſubſtance, zinc, for inſtance, is expoſed to a certain temperature, it alſo undergoes a very great change, during which heat and light are alſo given out. The zinc is changed to a light, flocculent ſubſtance, but moſt other metals are reduced to the form of powder (x).

308 Oxygen gas neceſſary in this proceſs.

Now, none of theſe changes can be effected without the preſence of atmoſpherical air, or rather without the preſence of oxygen gas, which is one of its conſtituent parts, and that part of it which is neceſſary for the proceſs of combuſtion. In all caſes where combuſtion takes place, oxygen gas diſappears or changes its ſtate; light and heat are emitted, and the combuſtible body has changed its properties. Such are the phenomena of combuſtion, ſo far as obſervation and experiment have gone; but ſtill the difficulty remains, to diſcover what ſhare is to be aſcribed to the different agents which are neceſſarily concerned in this proceſs, in the changes which are effected. It is now univerſally agreed, that oxygen gas, or its baſe, is fixed in the combuſtible body during the proceſs of combuſtion, and that the caloric which is neceſſary to retain the oxygen in the ſtate of an elaſtic fluid being emitted during the change, is the ſource of the heat which is given out by burning bodies. But what is the ſource of the light? Is it emitted by the oxygen gas along with the caloric in its change from the fluid to the ſolid ſtate? Or has it been a conſtituent part of the combuſtible body which is ſeparated during combuſtion? Of this, different opinions have been entertained by philoſophers, and the queſtion in a great meaſure ſtill remains undecided. Let us now conſider the different theories which have been propoſed to account for theſe phenomena.

309 Source of the light not aſcertained.

310 Theories.

1. In the early dawn of chemiſtry, when the ſcattered facts were firſt collected, and it began to aſſume a ſcientific form, attempts to explain this proceſs were ſoon made. Beccher was the firſt who gave any conſiſtent form to a theory of combuſtion. Before his time, ſulphur was conſidered as the univerſal inflammable principle; but he rejected this opinion, conſidering ſulphur as an inflammable ſubſtance, containing the principle of inflammability, but not that principle itſelf. This theory was improved and extended by Stahl, who gave this principle the name of *phlogiſton* (y), from which the theory was called the phlogiſtic, and from his own name the *Stahlian* theory. This principle was ſuppoſed to exiſt in all inflammable bodies, and to be the ſame in them all. The diverſity which is obſerved among them, in external appearance and other properties, is owing to the other principles or elements of which they are compoſed, and with which the common principle of inflammability, or phlogiſton, is combined. Inflammation or combuſtion, with the ſeveral phenomena that attend it, is ſuppoſed to depend on a gradual ſeparation and diſſipation of this principle; and this being once ſeparated, what remains of the body is no longer combuſtible, but is ſimilar to other kinds of matter. This principle is repreſented as a dry ſubſtance, of an earthy nature, compoſed of particles which more than all others are diſpoſed to be affected with a very ſwift whirling motion. When the particles of a body are agitated with this motion, the body becomes hot, is ignited, or undergoes combuſtion, according to its violence. The heat and the light which are emitted during combuſtion, depend upon a peculiar motion of the particles of matter; phlogiſton, which is ſuppoſed to be contained in all combuſtible ſubſtances, being moſt diſpoſed to aſſume this motion *.

311 Stahlian.

* Black's Lect. vol. i. p. 231, 232.

312 Hooke's.

2. But before this time, a different theory was propoſed by Dr Hooke, who publiſhed an account of it in 1665, in a work entitled *Micrographia*; and, in the year 1676, in another work called *Lampas*. According to this theory, the air of the atmoſphere is the univerſal ſolvent of all combuſtibles. This ſolution takes place when the temperature of the combuſtible body is ſufficiently raiſed, and during the violence of its action the heat is emitted. This diſſolution of inflammable bodies is a ſubſtance inherent in the air, which is like, if not the very ſame with, that which is fixed in ſaltpetre. During this diſſolution of bodies, part unites with the air and eſcapes; and part, after being mixed with it, forms a coagulum or precipitation, ſome of which being light, is carried away, while another part which is heavier, remains behind.

313 and Mayow's.

Some time after, an account of the ſame theory was publiſhed by Dr Mayow, with ſome additional experiments, in a work entitled *De Sal-nitro et Spiritu Nitro-aëreo*. The nitro-aërial particles, or the ſpiritus nitro-aëreus of Mayow, was the ſame as the univerſal ſolvent of Hooke. According to Mayow, this ſpiritus nitro-aëreus conſiſts of minute particles, from the motion of which it is produced, and when the motion is more rapid, not only heat, but light alſo, is extricated. The following abſtract of the theory of Dr Hooke, with Profeſſor Robiſon's obſervations, will not, we hope, be unacceptable to our readers.

314 Abſtract of Hooke's theory.

“ This theory, ſo oppoſite, as Dr Black obſerves, to the theory of Stahl, is not ſo recent as is generally imagined. It was ſeen, in all its extent and importance, by Dr Robert Hooke, one of the greateſt geniuſes and moſt ardent inquirers into the operations of nature, who figured during the latter half of the 17th century, a period full of great diſcoveries.

“ Dr Hooke propoſed this theory in conſiderable detail in his *Micrographia*, publiſhed in 1665; and in his *Lampas*, publiſhed in 1676; and he makes it an important doctrine in his treatiſe on Comets, and in many paſſages of his Cutlerian Lectures. He promiſes to take it into ſerious conſideration, and to publiſh a full exhibition of it. The alluſions made to it in his lectures make it evident that he had continued to make ſome deſultory additions to his firſt conceptions. His *Lampas* contains a moſt accurate explanation of flame, which cannot be ſurpaſſed by any performance of the preſent day.

(x) To theſe ſubſtances was formerly given the name of *calx* or *calces*, but in the preſent chemical nomenclature they are denominated *oxides*.

(y) This principle was alſo called *terra ſecunda* or *terra inflammabilis*.

"In the Micrographia he ſtates the theory in the following words:

"1. The air in which we live, and breathe, and move, and which encompaſſes and cheriſhes all bodies, is the univerſal ſolvent of all ſulphurous (ſynonymous, at that time, with inflammable) bodies.

"2. This action it performs not till the body be ſufficiently heated, as we obſerve in other ſolutions.

"3. *This action of diſſolution produces the great heat which we call fire.*

"4. It acts with ſuch violence as to agitate the particles of the diaphanous body air, and to produce that elaſtic pulſe called light.

"5. This action, or diſſolution of inflammable bodies, is performed by *a ſubſtance inherent in, and mixed with the air, that is like, if not the very ſame with, that which is fixed in ſaltpetre.*

"6. In this diſſolution of bodies by the air, a part of the body, uniting with the air, is diſſolved or turned into air, and eſcapes and flies about.

"7. As one part is thus turned into air, ſo another is mixed with it, but forms a coagulum, or precipitation, ſome of which is ſo light as to be carried away with the air, while other groſſer and heavier matters remain behind, &c. &c. This latter article is frequently employed in other parts of his writings, and is ſometimes called a groſſer *compound*, mixed with matters terrene, and originally inſoluble in air, and incombuſtible.

"Can any thing more be wanting to prove that this is the ſame with the modern theory of combuſtion? Nothing but to ſhew that this coagulum contained the air which had formed it, by ſhewing an increaſe of its weight, or by ſeparating it again. But the eager mind of Hooke, attracted by every appearance of novelty, was ſatisfied with the general notion of a great ſubject, and immediately quitted it in chaſe of ſome other intereſting object. Had he not been thus led off by a new purſuit, this wonderful man would not only have anticipated, but completed many of the great diſcoveries of the laſt century. It was a bold conception, and only a vigorous mind could entertain it for a moment, that the vaſt heat of combuſtion was contained in a few grains of air. Yet this was his opinion, as appears by the explanation which he gives, in various meetings of the Royal Society, and in his lectures on comets, of the deflagration of combuſtible bodies with ſaltpetre, and of fiery motion.

"In the treatiſe called Lampas, he obſerves that this his treatiſe, publiſhed eleven years before, had been very favourably received, and that he had not ſeen any valid objection offered to it. It was in this interval that Dr Mayow, at Oxford, publiſhed his book *De Sal-Nitro, et Spiritu Nitro-aëreo*, in which he holds preciſely the ſame doctrine; but his exhibition of it is obſcure, complicated, and wavering, mixed with much mechanical nonſenſe, of wedges, and darts, and motions, &c. according to the faſhion of the times. Hooke's conception of the ſubject, on the contrary, is clear, ſimple, and ſteady. The only addition made by Mayow are ſome obſervations on the increaſe of weight obſerved in the preparation of diaphoretic antimony, &c. Hooke, explaining at a meeting of the Royal Society, ſome tricks of the plumbers workmen, who called the litharge which formed on the ſurface of melted lead droſs, and took it with them as their perquiſite, ſays expreſsly, that they can make droſs of the whole, and that it is more than the lead by all the air which was its menſtruum. But Mayow wrote on the ſubject expreſsly, and it appears in the title of his book. He is remembered, while Hooke is forgotten, becauſe no one would think of looking into the Micrographia for chemical information. The theory comes in by chance, to explain the indeſtructibility of charcoal in cloſe veſſels by heat. Mayow alſo made many very ingenious experiments on the air which had contributed to inflammation, and has anticipated both the manipulations and the diſcoveries of modern pneumatic chemiſtry."

315 Phlogiſton ſuppoſed to be light.

3. But in the progreſs of chemical ſcience, the exiſtence of the imaginary principle of phlogiſton began to be called in queſtion. It had been obſerved, and was proved by experiment, that ſubſtances became inflammable by merely being expoſed to the light of the ſun, and in this way having acquired the principle of inflammability, it was ſuppoſed to be the ſame as light. This opinion of phlogiſton being light fixed in bodies, which was the firſt improvement or modification of the theory of Stahl, was adopted by Macquer and other chemiſts.

316 Farther modified.

317 Changes obſerved on the air by Prieſtley,

318 ſuppoſed that it combined with phlogiſton.

4. In the progreſs of diſcovery, this theory was ſtill farther modified. The introduction of pneumatic chemiſtry, and the accuracy and preciſion which it gave to the experiments and reſearches of chemiſts, enabled them to aſcertain, with greater certainty, the changes which take place on bodies after being ſubjected to combuſtion, as well as on the air in which they are burnt. Some of theſe changes were obſerved by Dr Prieſtley, whoſe indefatigable labours contributed eſſentially to the extenſion of chemical ſcience. He found by experiment, that the air in which combuſtibles had been burnt, was afterwards unfit for the ſupport of flame, and equally ſo for the breathing of animals. He aſcribed this change which the air had ſuffered to its combination with the phlogiſton which had ſeparated from the burning body during the proceſs of combuſtion. He conſidered air as neceſſary to combuſtion, becauſe, having a ſtrong affinity for phlogiſton, it attracted it during the proceſs, and combined with it; and by this combination the air was contaminated and rendered unfit for farther combuſtion, or for animal reſpiration. But ſtill the difficulty remained to account for the heat and light which are extricated during this proceſs.

319 Caloric and light exiſt in the air.

According to Dr Crawford, the caloric and light which appear during combuſtion, exiſt in the air in which the body is burnt, and during the proceſs the phlogiſton combines with the air, from which at the ſame time the light and caloric are ſeparated.

320 Phlogiſton the ſame with hydrogen.

5. Soon after Mr Kirwan propoſed another opinion, which was pretty generally adopted by chemical philoſophers. According to this opinion, hydrogen and phlogiſton are the ſame; that it exiſts as a conſtituent part in all combuſtibles, ſeparating from them during combuſtion, and combining with the oxygen of the air.

321 Scheele's hypotheſis.

6. In the year 1777, Scheele publiſhed a work which was entitled, *Chemical Experiments on Air and Fire.* Heat according to him, conſiſts of a certain

quantity of oxygen united with phlogiſton. Radiant heat, which moves in ſtraight lines, is compoſed of oxygen combined with a greater proportion of phlogiſton; and light, of oxygen combined with a ſtill greater quantity.

322 Diſcovery of Lavoiſier.

7. But the labours and diſcoveries of the French chemiſts gave a new turn to chemical ſcience. The unfortunate Lavoiſier, who had devoted his time and his fortune to chemical purſuits, had long directed his attention to the phenomena of combuſtion; and after an extenſive ſeries of experiments, diſtinguiſhed for their accuracy and preciſion, he eſtabliſhed the general law, that oxygen combines with the burning body in all caſes of combuſtion; and thus, he was enabled ſatisfactorily to account for the phenomena of combuſtion without phlogiſton, the exiſtence of which had never been proved.

323 His theory.

8. The principles of this theory are the following. No combuſtion can take place without the preſence of oxygen, for it is the combination of the combuſtible body with oxygen. The oxygen of the atmoſphere, which is in the ſtate of an elaſtic fluid, exiſts in combination with caloric and light; and during the combuſtion, that is, the combination of the oxygen with the combuſtible body, the caloric and light are ſeparated.

324 Accounts only for ſome of the phenomena.

9. This theory accounts for the phenomena of combuſtion in the more limited acceptation of this term, which is merely the combination of oxygen with a combuſtible body, without any extrication of caloric and light. Thus, oxygen combines with ſome metallic ſubſtances and other bodies, without any perceptible emiſſion of light or heat. This is called *oxidation*, and the product of this combuſtion is denominated an *oxide*. In all caſes of combuſtion oxygen combines with the combuſtible body. Indeed this is ſo eſſentially neceſſary, that no combuſtion can take place without it; but in the more extenſive ſignification of the term combuſtion, it is underſtood, not merely to mean the combination of oxygen with the combuſtible body, but alſo to be accompanied with the extrication of heat and light. According to the theory of Lavoiſier, the caloric and light which appear during combuſtion, are given out by the oxygen gas. It is the ſeparation of that quantity of caloric which is neceſſary to retain the baſe of this gas, or oxygen, in the form of an elaſtic fluid. When, therefore, the temperature of a body is ſufficiently raiſed, the affinity between oxygen and this body becomes greater than that which exiſts between the oxygen, and the caloric and light. The oxygen therefore combines with the combuſtible body, and the caloric and light are ſeparated.

This theory is applicable to the explanation of the phenomena of combuſtion, in the more limited meaning of that term; and it is partially applicable to explain the phenomena in its more extenſive meaning. But when it is conſidered, that the proceſs of combuſtion goes on between two ſolids, one of which contains oxygen in its combination, as for inſtance, ſulphur and nitre, difficulties ariſe in accounting for the heat and light, when the oxygen which combines with the combuſtible body, is in the ſolid ſtate.

To remove theſe difficulties, and to explain the appearances, the theory of Lavoiſier has been greatly modified, or new theories propoſed.

325 Theory of Brugnatelli.

10. With this view a theory has been propoſed by Brugnatelli. This theory ſuppoſes that oxygen exiſts in combination with bodies, in two ſtates. In the one it is entirely deprived of its caloric and light, and in the other, it retains great part of the caloric and light, even in its combined, concrete ſtate. It is ſimply called *oxygen* in the firſt caſe, when it is deprived of its caloric and light; in the latter it is denominated *thermoxygen*, when the caloric and light are combined with it in the concrete ſtate. Thermoxygen, then, is a compound of oxygen and caloric in the concrete ſtate. This caloric is different from that which holds the thermoxygen in the ſtate of gas, and it is in the ſame relation to thermoxygen gas, as water is to cryſtallized ſalts. This thermoxygen only enters into the compoſition of acids, when it is deprived of its concrete caloric. But it combines with the metals in the ſtate of thermoxygen; that is, united with the concrete part of caloric. Metallic ſubſtances, therefore, are denominated *thermoxides*.

In its union with metals, thermoxygen is either previouſly formed, or is in its naſcent ſtate, during the combination. In the latter caſe, the caloric which is diſengaged by the chemical action, or that which is applied to aſſiſt the combination, furniſhes the neceſſary portion for the formation of the thermoxide; that is, the combination of oxygen containing caloric in its concrete ſtate, with a metal. Thus it is, that ſome metals require the application of heat for their ſolution in concentrated acids.

The baſe of pure air is in the ſtate of thermoxygen, in its combination with water. The metals, therefore which have a ſtronger affinity for it than for hydrogen, the other component part of water, readily combine with it, without the aid of external heat, in acids diluted with this fluid. Gaſeous thermoxygen always gives out caloric, when it paſſes from the elaſtic to the concrete ſtate; but as thermoxygen requires little caloric for its expanſion, little is ſeparated when it is condenſed. We ſhall only add the author's explanation of the difference between atmoſpherical air and thoſe ſubſtances which have the ſame conſtituent parts in different proportion. The difference between atmoſpherical air and nitrous gas, he ſuppoſes, is aſcribed to the proportion of the conſtituent principles, and conſequently, according to this hypotheſis, the atmoſpherical air might be converted into nitrous gas, by augmenting the proportion of oxygen gas, or by diminiſhing that of the azotic gas. But the difference between theſe two gaſes, according to the theory of Brugnatelli, conſiſts in this, that in atmoſpherical air the azotic gas is combined with thermoxygen gas; but in nitrous gas, the azotic gas is combined with ſimple oxygen *.

326 Theory which ſuppoſes the light to be given out by the combuſtible.

11. This theory, notwithſtanding its ingenuity, is regarded by ſome merely as a plauſible hypotheſis, which is little ſupported by facts. We ſhall therefore leave it to the conſideration of our readers, and proceed to ſtate the principles of another, which is propoſed to be ſubſtituted in place of the Lavoiſierian theory, in explaining the phenomena of combuſtion. In this theory, it is ſuppoſed that the oxygen gas which is abſorbed during combuſtion, furniſhes the caloric, while the combuſtible body gives out the light which previouſly exiſted in it as a component part. In proof

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* *Annal. de Chim.* vol. xxix. p. 182.

327 Light furniſhed by the combuſtible.

of this theory it is ſtated, that ſome bodies give out, during combuſtion, a greater quantity of light than others, even where the quantity of oxygen abſorbed is leſs; that the colour of this light varies according to the nature of the combuſtible; and that vegetables which grow in the dark contain no combuſtible matter, being deprived of the light which is eſſentially neceſſary for its formation. This theory, which Gren calls *the theory of fire and combuſtion*, is diſtinctly detailed by him in the following words:

“ I take here the word *fire* in the uſual ſenſe of common language, and underſtand by it that light which is combined with free caloric. *Combuſtion* is the extrication of fire with and by the decompoſition of oxygen gas. Take the example of phoſphorus. On its combuſtion two new products, the phoſphoric acid and fire, ariſe from phoſphorus and oxygen gas.

328 A theory muſt explain all the phenomena.

“ In order that the theory of combuſtion be admiſſible, it muſt explain every circumſtance by which this phenomenon is accompanied, and be in contradiction with none of them. It, beſides, muſt not be inconſiſtent with any other fixed invariable law of nature.

“ According to the *antiphlogiſtic ſyſtem*, a combuſtible body is ſuch as is poſſeſſed of the power of attracting, in a certain temperature, the oxygen of vital air more ſtrongly than it is attracted by the caloric. Beſides, in that ſyſtem, oxygen gas does not merely conſiſt of oxygen and caloric, but it likewiſe contains light, in a fixed ſtate, as a conſtituent part.

“ If, therefore, phoſphorus, at the temperature requiſite to its inflammation, be brought into oxygen gas, it robs the latter of its oxygen, and makes with it phoſphoric acid; whilſt the caloric and the baſis, or matter of light, previouſly *latent* in the gas, are reſtored to liberty; and, combining together, produce the fire which flies off. Thus the oxygen gas is decompoſed.

329 New body generated by combuſtion.

“ A new body, the phoſphoric acid, is now generated; and, becauſe in many caſes an acid is produced by the combuſtion of inflammable matters, this circumſtance has induced modern chemiſts to denote the baſis of vital air by the words *acidifying principle*, or *oxygen*; not on the ground that it is ſuppoſed to be ſour of itſelf, but becauſe it forms an acid only when combined with an *acidifiable baſis*, as in our experiment with phoſphorus. And it is on this account that, in this ſyſtem, combuſtion has likewiſe received the name of *oxygenation*. But in the caſe (very often occurring) where the combuſtible matter imbibes oxygen, yet without becoming thereby an acid, the product is called *oxyd* (alſo denominated *half-acid*), and the proceſs is termed *oxydation*.

“ Since the combuſtible ſubſtance takes up the ponderable baſis of oxygen gas, and ſince, according to this ſyſtem, both the caloric and light are imponderable, it is thereby accounted for, why the reſidue of burnt matters, the phoſphoric acid, for inſtance, acquires an increaſe of weight equal to that portion of vital air which was decompoſed.—If the inflammable ſubſtance be ſaturated with oxygen, it is rendered incapable of decompoſing more oxygen gas, and the combuſtion is ended.

330 Acquires an increaſe of weight.

“ When the combuſtion is performed in atmoſpheric air, it is then the azotic, either mingled or mixed with the oxygen gas, that prevents theſe phenomena from going on with the ſame vivacity as in pure oxygen gas; and likewiſe, as the azotic gas is not affected or acted on by the inflammable body, it is left as the reſidue of the atmoſpheric air.

331 Combuſtion a caſe of ſimple affinity in the old theory.

“ Hence, by that ſyſtem, the combuſtion of phoſphorus in oxygen gas is effected by a ſimple affinity, and the principle of fire is not in the combuſtible body, but in the oxygen gas.

332 Explained by double affinity.

“ However, from what I have ſtated of the compoſition of light, I cannot help thinking, that in combuſtion a double affinity takes place; and to explain this theory I ſhall ſelect the example of phoſphorus. That ſubſtance conſiſts of the baſis of light, called by me *phlogiſton*, and making a conſtituent part of all combuſtible bodies united to a peculiar body, the *phoſphoric-radical*.—*Oxygen gas* is a compound of *oxygen* and *caloric*.

“ Now, when phoſphorus is heated in this gas, and by this means the force of attraction between the phlogiſton and the phoſphoric-radical is ſufficiently weakened, ſo that the attractive power between the radical of phoſphorus and the oxygen may prevail, then the act of combuſtion enſues. The phoſphoric baſis attracts the oxygen, while the phlogiſton of the phoſphorus is attracted by the caloric of the oxygen gas. Thus, by virtue of this double affinity, two new compounds, the phoſphoric acid and fire, ariſe from the two former combinations, phoſphorus and oxygen gas.

“ When the radical of phoſphorus, and in general of any combuſtible body, has abſorbed ſo much oxygen, that it is ſaturated with it, the combuſtion is arrived at its higheſt degree; and in the ſame manner it is ended, at the moment when all the quantity of oxygen gas, capable of being decompoſed, is exhauſted. By this it is explained, why, in a given volume of oxygen gas, only a certain quantity of phoſphorus, and in general of every other combuſtible matter, can be conſumed by fire.

“ The increaſe of weight in the reſidue of the burnt ſubſtance is, in this phlogiſtic, or rather *eclectic ſyſtem*, likewiſe explained by the acceſs of oxygen; and the caloric and baſis of light are likewiſe ſuppoſed to be both imponderable. The remaining azotic gas, not being acted upon by the combuſtible matter, is merely the reſidue of the atmoſpheric air.

333 Light given out without oxygen.

“ Thoſe that wiſh to be impartial, muſt allow that the light, in the *antiphlogiſtic ſyſtem*, acts a part quite ſuperfluous; that it may be thoroughly ſet aſide without impairing the ſyſtem; that by this ſyſtem thoſe phenomena cannot be explained, where light iſſues from combuſtible bodies without any acceſs of vital air, (ſome inſtances of which will hereafter be given (z)); that the influence of light upon the growth and thriving of plants, upon the changes of their mixture during

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(z) As in the caſe of the combination of ſulphur and iron or copper.

g vegetation, and upon the alteration in the mixture of many other bodies, is by far too great, to allow oxygen gas to be conſidered as its only reſervoir. Finally, it muſt be granted (an important point) that the antiphlogiſtic ſyſtem does in no way explain the incidents preliminary to the proceſs of combuſtion; and that it affords no argument to ſhow why a certain degree of heat is neceſſary, in order that the combuſtible body be inflamed *."

* Gren's Chemiſtry, vol. i. p. 135.

334 Three modifications. 11. Such then are the general facts with regard to combuſtion, and ſuch are the theories which have been propoſed, to account for the phenomena exhibited in this proceſs. Three ſtates or modifications have been diſtinguiſhed in the act of combuſtion, namely, ignition, inflammation, and detonation.

335 Ignition. *a.* Ignition, properly ſpeaking, is rather a preliminary ſtep, than a part of the proceſs of combuſtion itſelf. A metallic ſubſtance, for inſtance, may become red hot when expoſed to a certain temperature; but when it is cooled, it returns without change to its former ſtate. In this caſe caloric and light are given out, but the body undergoes no farther change. There is no abſorption of oxygen, which is one of the ordinary phenomena of combuſtion. But, with an increaſe of temperature, this alſo is effected, and the whole phenomena of combuſtion are exhibited; namely, the union of oxygen with the combuſtible body, and the emiſſion of light and heat.

336 Inflammation. *b.* The ſecond ſtate or modification of combuſtion is called *inflammation*. This depends on the nature of the combuſtible body, owing partly to its ſtrong affinity for oxygen, and partly to the ſlight affinity which exiſts between the particles of the combuſtible body. We have examples of this in the burning of ſulphur or phoſphorus, or a candle in the open air, or in oxygen gas.

337 Detonation. *c.* Detonation is another modification of combuſtion. It is a rapid and inſtantaneous inflammation, accompanied with exploſion. This ariſes from the ſudden formation of a vacuum, by the change of elaſtic fluids into the liquid ſtate, or by the ſudden evolution of elaſtic fluids from the ſolid ſtate. Of the firſt we have an inſtance in the compoſition of water by the inflammation of oxygen and hydrogen gaſes, which is attended with a violent exploſion, great condenſation, and the extrication of light and heat. Of the evolution of elaſtic fluids from ſolid bodies, we have a good inſtance in common gunpowder, from which an immenſe volume of elaſtic vapour is inſtantaneouſly extricated, which, by its expanſive force being ſuddenly exerted, produces the exploſion, and the irreſiſtible effects of this powerful agent.

338 Combuſtible ſubſtances converted into acids, 339 or water, 340 or oxides. 12. All inflammable ſubſtances, Dr Black obſerves, are changed, during combuſtion, into one or more principles. From the combuſtion of ſome ſubſtances, as ſulphur and phoſphorus, an acid is obtained. From the combuſtion of others, as hydrogen with oxygen, water is the product; and in the caſe of metals, they are reduced to the ſtate of oxide, or *calx*, as it was formerly called. After the combuſtible ſubſtance has been ſubjected to the proceſs of combuſtion, it is totally changed in its properties, and it can no longer exhibit the phenomena of combuſtion.

Such then are the general properties and effects of light and heat, two of the moſt powerful agents, and of the moſt extenſive influence, in all the changes and combination which take place among bodies, by chemical action. In many properties they reſemble each other, but are totally different from all other kinds of matter. Theſe bodies, poſſeſſed of a repulſive power among the particles of each other, are attracted by other bodies, and combine with them; and theſe combinations produce the moſt aſtoniſhing effects, giving new forms to matter, and inducing innumerable changes, which may be conſidered as conſtituting the principle and eſſence of ſome of the moſt ſublime operations of nature, and many of the moſt important proceſſes of art.

Connected with light and heat in many of their obvious properties, and alſo in many of the changes which they produce upon bodies, are electricity and galvaniſm; and with electricity at leaſt, if not alſo with galvaniſm, the magnetic power poſſeſſes ſome common properties; and eſpecially if ſome of theſe are to be conſidered, as ſome have ſuppoſed, only as modifications of the ſame ſubſtances which we have treated of, the diſcuſſion of theſe ſubjects would be properly introduced here; but, according to the nature and arrangement of this work, each will be fully detailed under its proper head. See Electricity, Galvanism, Magnetism.

Chap. IV. Of OXYGEN, and OXYGEN GAS.

1. Oxygen gas, or its baſe, oxygen, is one of the moſt important agents in the chemical phenomena of nature, or in the proceſſes of art. There is indeed ſcarcely a ſingle proceſs in which this ſubſtance has not ſome ſhare. Its nature and properties, therefore, ought to be early known. 341 Of great importance.

Oxygen gas is one of the diſcoveries of modern chemiſtry. It was diſcovered by Dr Prieſtley in the year 1774, and from him it received the name of *dephlogiſticated air*. It was afterwards denominated *highly reſpirable air*. From Scheele, who diſcovered it in 1775, it received the name of *empyreal air*. It was called *vital air* by Condorcet; and Lavoiſier gave it the name of *oxygen gas*, by which it has ſince been generally diſtinguiſhed. 342 A diſcovery of modern chemiſtry.

2. Oxygen gas is moſt eaſily obtained by the following proceſs: *a.* Take a quantity of the ſubſtance called *manganeſe*; introduce it into the iron bottle A, fig. 3. to the neck of which apply the bent tube B, which is made to fit it exactly, and lute them together at the joining CD (A). The bottle thus prepared, is to be expoſed 343 Proceſſes for obtaining it.

(A) The lute which anſwers this purpoſe ſufficiently well, is compoſed of pipe clay and linſeed oil well beaten together, and reduced to the conſiſtence of glaziers putty. This is neatly applied to the joining, and if allowed to remain for eight or ten hours before it is expoſed to the heat, it will afterwards bear the higheſt temperature.

expoſed to the heat of a furnace, or to that of an open fire. As ſoon as the heat is applied, the atmoſpheric air within the bottle is driven off; and, as the bottle becomes red hot, the quantity of air which paſſes over, is greatly increaſed. Let the end of the tube connected with the bottle be introduced under the ſhelf in the pneumatic trough, and the bubbles of air will paſs through the water, and may be received in jars filled with water, and inverted over the opening in the ſhelf.

b. Oxygen gas may alſo be obtained by treating what is called in chemiſtry the *red oxide of mercury*, in a ſimilar manner.

c. This gas may be alſo readily procured by introducing into a glaſs retort, a quantity of the ſame ſubſtance (manganeſe) reduced to powder, adding an equal weight of ſulphuric acid, and applying a moderate heat.

d. Or it may be obtained from the ſubſtance called *nitre* or ſaltpetre, expoſed to a red heat, in an earthen or coated glaſs retort.

344 Nature of the proceſs explained.

3. In all theſe methods of obtaining this gas, it is unneceſſary to mention, that it muſt be received in the pneumatic apparatus, in the ſame way as has been directed for procuring it from the manganeſe, expoſed to heat in the iron veſſel; and in whatever way it is obtained, the chemical change which takes place in theſe proceſſes, is thus explained. Oxygen gas conſiſts of two ingredients, the one, which is called its baſe, and the other *caloric*, or the matter of heat. In the manganeſe, this baſe is ſuppoſed to be combined with the metallic ſubſtance; and when this ſubſtance is expoſed to a ſufficient temperature, the oxygen, having a greater attraction for caloric than for the metal, combines with it, and paſſes off in the ſtate of gas. The ſame change takes place, when the proceſs for obtaining the gas, by means of the red oxide of mercury, is employed. When the ſulphuric acid, which is in the ſtate of liquid, is added to the manganeſe, it combines with it, and becomes ſolid. But no liquid ſubſtance can become ſolid, without being deprived of the caloric neceſſary to retain it in the ſtate of fluidity. The caloric which retained the ſulphuric acid in the liquid ſtate, combines with the oxygen of the manganeſe, aſſumes the fluid or gaſeous form, and makes its eſcape. This is an example of double affinity. The ſulphuric acid unites with the manganeſe, and forms a ſolid, while the caloric combines with the baſe of oxygen, and appears in the form of oxygen gas.

345 Properties.

4. Oxygen gas thus obtained, poſſeſſes many of the properties of common air. It is colourleſs, inviſible, elaſtic, and may be indefinitely expanded or compreſſed.

Oxygen gas poſſeſſes neither taſte nor ſmell; its ſpecific gravity, according to Mr Kirwan, is to that of water as 0.00135 to 1.0000. Being therefore 740 times lighter than its bulk of water, its weight to atmoſpherical air is in the proportion of 1103 to 1000; or 100 cubic inches of oxygen gas weigh 34 grs. while the ſame meaſure of atmoſpherical air weighs only 31 grs. the temperature being 60°, and the barometer being at 30 inches. According to Mr Davy's experiments, 100 cubic inches of oxygen gas weigh 35.05 grs.

Water does not ſenſibly abſorb oxgen gas. But by means of ſtrong preſſure, it may be made to combine with, and to retain in ſolution, half its bulk of the gas. The water thus impregnated, is not ſenſibly different from commom water in taſte or ſmell, but it is ſaid to have proved an uſeful remedy in ſome diſeaſes.

346 Combuſtion more brilliant in oxygen gas.

Combuſtible ſubſtances burn with greater brilliancy and rapidity in oxygen gas than in common air. Indeed it is owing to a certain quantity of the former, that the proceſs of combuſtion goes on in the latter; and when the oxygen gas is exhauſted, the proceſs is interrupted. If a jar or phial is filled with this gas, and a lighted candle introduced into it, it burns with greater ſplendour, and produces a greater degree of heat, than in a ſimilar veſſel filled with common air. If the candle be blown out, and while the ſnuff is red hot, it is introduced into a veſſel filled with oxygen gas, it re-kindles with a ſlight exploſion, and burns with the ſame ſplendour. A candle in a veſſel filled with oxygen gas burns much longer than in the ſame quantity of atmoſpherical air.

347 Animals live a longer time in it.

Oxygen gas is eſſentially neceſſary for reſpiration. No breathing animal can live in any air which does not contain ſome proportion of oyxgen gas. And the experiments of Dr Prieſtley and others prove, that animals live a much longer time in oxygen gas than in an equal bulk of atmoſpherical air. The experiments of Count Morozzo fully eſtabliſh this fact. Into a veſſel filled with common air, and inverted over water, he introduced a number of ſparrows, and obſerved the effects. The following are the reſults of his experiments:

	H.	M.
The firſt ſparrow lived	3	0
The ſecond	0	3
The third	0	1

The experiments were repeated by filling the ſame veſſel with oxygen gas, and he obtained the following reſults:

	H.	M.
The firſt ſparrow lived	5	23
The ſecond	2	10
The third	1	30
The fourth	1	10
The fifth	0	30
The ſixth	0	47
The ſeventh	0	27
The eighth	0	30
The ninth	0	22
The tenth	0	21

Two ſparrows were then put in together; the one lived for an hour, but the other died in about 20 minutes.

348 Oxygen combines with bodies.

5. Oxygen combines with a great number of bodies, and forms compounds with them. It is always preſented to us in a ſtate of combination. In examining its properties, it is always as a compound; and theſe properties are only cognizable to our ſenſes in that ſtate.

When oxygen combines with metallic ſubſtances, they acquire new properties, and this combination in chemical language is denominated an *oxide*. Combined with many other ſubſtances, the nature of the ſubſtance is alſo changed, and the compound exhibits new properties. One of the moſt remarkable of theſe is the taſte of the compound ſubſtance, which is often ſour or acid; and becauſe this circumſtance was obſerved to be one of the moſt frequent and moſt re-

349 Origin of the name.

markable which attend its combinations, the name of oxygen, or acidifying, was invented by Lavoiſier. Oxygen gas is alſo neceſſary for the germination of the ſeeds of plants: but as the proceſs of vegetation advances, it is given out in great abundance by the leaves during the day. By this means the great waſte of oxygen gas in the proceſſes of combuſtion and reſpiration is fully repaired, and the balance between its conſumption and ſupply is preſerved.

6. The following is the order of its affinity for the ſubſtances with which it enters into combination.

OXYGEN.

Charcoal,
Titanium,
Manganeſe,
Zinc,
Iron,
Tin,
Uranium,
Molybdena,
Tungſten,
Cobalt,
Antimony,
Hydrogen,
Phoſphorus,
Sulphur,
Azote,
Nickel,
Arſenic,
Chromium,
Biſmuth,
Lead,
Copper,
Tellurium,
Platina,
Mercury,
Silver,
Oxide of arſenic,
Nitrous gas,
Gold,
Muriatic acid,
White oxide of manganeſe,
White oxide of lead.

CHAP. V. OF AZOTIC GAS.

350 Diſcovery.

1. AZOTIC gas was examined by Mr Scheele, the celebrated Swediſh chemiſt, in 1776; and his experiments proved, that it is a fluid poſſeſſed of peculiar properties. It ſeems, however, to have been known to Dr Rutherford of Edinburgh, as early as the year 1772, as appears from his theſis publiſhed in that year, in which he ſpeaks of the effects of combuſtion and reſpiration on the air of the atmoſphere.

351 Methods of procuring it.

2. There are various methods by which this gas may be obtained. *a.* The proceſs recommended by Berthollet is the following: Take a quantity of muſcular fleſh, or the fibrous part of the blood, which has been well waſhed. Cut the fleſh into ſmall bits; introduce it into a retort, or a matraſs to which a ground tube has been adapted. Pour over it diluted nitric acid, expoſe it to a heat of about 100°, and place the beak of the retort or the end of the tube in the pneumatic apparatus, that the gas which comes over may be received in proper veſſels. The gas thus obtained, is *azotic* gas. *b.* If ſulphuret of potaſh be expoſed to the air of the atmoſphere, incloſed in a bell-glaſs, over water; or, if ſulphuret of iron be formed into a paſte with water, and treated in the ſame way, and allowed to remain for ſome days, the quantity of air within the glaſs is greatly diminiſhed, in conſequence of part having been abſorbed, and what remains is azotic gas. *c.* When the air of the atmoſphere is incloſed in the ſame way, and expoſed to the action of phoſphorus, it alſo ſuffers diminution, part being abſorbed. Azotic gas only remains.

352 Properties.

3. Azotic gas, like common air, is inviſible and elaſtic, and may be indefinitely condenſed and dilated. Its ſpecific gravity is leſs than that of atmoſpheric air. It is eſtimated by Mr Kirwan at 0.00120, which is in the proportion of 985 to 1000; but according to Lavoiſier's experiments, it is to atmoſpheric air as 942.6 to 1000, which makes its ſpecific gravity only 0.00115.

This gas is unfit for combuſtion. If into a jar or phial, filled with azotic gas, a lighted candle be introduced, it is immediately extinguiſhed.

This gas is alſo extremely noxious to animals, and is therefore totally unfit for reſpiration.

353 Is a ſimple ſubſtance.

4. No attempts which have yet been made, have ſucceeded in decompoſing azote, or the baſe of azotic gas. It muſt therefore be admitted among the number of ſimple ſubſtances. It has never been obtained in a ſeparate ſtate. It is therefore when it is combined with caloric, that is, in a gaſeous ſtate, that we are acquainted with its properties; and from its being unfit for reſpiration, it derived its name. Some chemiſts have indeed conſidered it as a compound ſubſtance. Dr Prieſtley ſuppoſed that it conſiſted of phlogiſton and oxygen gas. On this account he called it *phlogiſticated air.* According to the Stahlian theory, the proceſs of combuſtion is the ſeparation of phlogiſton from the burning body. Oxygen gas, having a ſtrong affinity for phlogiſton, combines with it during the combuſtion, and is even ſuppoſed to contribute to the ſeparation of the phlogiſton, by its affinity for it. And when this air is ſaturated with phlogiſton, the proceſs of combuſtion is at an end. The air that remains after this proceſs is azotic gas. This theory, when firſt announced by Dr Prieſtley, was pretty generally received; but future experiments ſoon demonſtrated, that the quantity of air in which a combuſtible body was burnt, diminiſhed both in bulk and in weight; and therefore proved that the air, inſtead of receiving any addition, was on the contrary deprived of ſomething.

Achard, about the year 1784, concluded, from ſome experiments which he had made, that azotic gas conſiſts of water and fire. This theory has been ſupported by Weſtrumb, and more lately by Wiegleb. According to the experiments on which theſe chemiſts reſt the truth of their theory, azotic gas is always the reſult when ſteam is made to paſs through red-hot earthen, or even metallic tubes; but a ſeries of very accurate experiments, inſtituted by the aſſociated Dutch chemiſts, clearly proved that no azotic gas was produced, when the inſtruments employed were impenetrable by air *. Dr Prieſtley had long before ſhown, that in ſimilar experiments, when he employed earthenware retorts, containing moiſt clay, and expoſed them to a temperature above boiling heat; inſtead of vapour iſſuing from the beak of the retort, a quantity of air, which was nearly equal in weight to the quantity of water introduced, paſſed over. The concluſion which he drew from theſe experiments, was, that the water was converted into air; for he found that it poſſeſſed nearly the ſame properties as common air. But he proved afterwards by more accurate experiments, that water had made its way through the pores of the veſſels, and that its place was ſupplied by the external air which was forced in by the preſſure of the atmoſphere. For it was clearly aſcertained by the experiments of the Dutch chemiſts, that no gas was obtained, while perfectly ſound glaſs or metallic tubes were employed.

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* *Annal. de Chim.* vol. xxvi. p. 310.

Another theory has been propoſed, of the compoſition of azotic gas, by Girtanner[*]. He ſuppoſes that azotic gas conſiſts of hydrogen and oxygen gas, having a ſmaller proportion of oxygen gas than what enters into the compoſition of water[†]. But the experiments of other chemiſts, as thoſe of Berthollet and Bouillon Lagrange, have afforded no ſuch reſult (B).

354 Combinations

5. There is no perceptible action between light and azotic gas. Combined with caloric, we have already ſeen it may be indefinitely expanded, but without undergoing any change in its properties.

355 With caloric.

Azotic gas, from its being found in ſuch abundance in the air of the atmoſphere, no doubt acts ſome important part in the economy of nature. It is given out, or ſeems to be given out, in great quantity during the decompoſition of animal and vegetable matters; but during theſe proceſſes, it is the oxygen of the atmoſpherical air which is abſorbed, and thus the reſiduary air is azotic gas. The baſe of azotic gas is unknown, and chemiſts are ſtill unacquainted with its affinities.

356 With oxygen in different proportions.

Azotic gas combines with oxygen in different proportions, and forms compounds very different in their nature and properties. In one proportion it conſtitutes the air of the atmoſphere, in another, what is called *nitrous oxide*, and in a third *nitrous gas*. Theſe we ſhall examine in their order in the following ſections.

SECT. I. *Of* ATMOSPHERIC AIR.

357 Properties.

1. The air of the atmoſphere is compoſed of azotic and oxygen gaſes. This is an inviſible elaſtic fluid, which may be indefinitely compreſſed and dilated. The ſpecific gravity of atmoſpheric air is 0.0012, or about 816 times lighter than water. This is to be underſtood when the temperature is between 50° and 60°, and when the barometer is at 30 inches. The preſſure of the air of the atmoſphere is nearly equal to 15lb. on every ſquare inch.

2. Till the diſcoveries of modern chemiſtry, atmoſpheric air was conſidered as one of the four ſimple elementary ſubſtances, of which all bodies are compoſed. But the experiments and reſearches of Prieſtley and of Scheele fully demonſtrated the exiſtence of two ſeparate ſubſtances, totally diſtinct from each other in their natures and properties. Oxygen gas, one of the component parts of atmoſpheric air, was, according to Dr Prieſtley, completely freed from phlogiſton; and hence he calls it dephlogiſticated air, which was in an eminent degree, fit for reſpiration and combuſtion; but azotic gas, the other component part, was ſuppoſed to be ſaturated with phlogiſton, and therefore unfit, as it was found to be, for theſe purpoſes. To the latter, the azotic gas, Scheele gave the name of *foul* air.

358 Proportions of azotic and oxygen gaſes

3. According to the experiments of Lavoiſier, the proportion of the two gaſes which exiſt in atmoſpheric air, are 73 parts of azotic gas, and 27 of oxygen gas. But according to later experiments the proportions are found to be 78 of azotic gas, and 22 of oxygen gas by bulk; or by weight, 74 of azotic and 26 of oxygen gas.

359 always conſtant.

The proportions of theſe two gaſes in atmoſpheric air are uniform and conſtant. They have been found to be nearly the ſame in all parts of the world, and in all ſeaſons of the year, where experiments have been made.

360 Conſtitution of the atmoſphere.

361 Suppoſed to be a chemical combination,

4. A queſtion has ariſen among philoſophers concerning the conſtitution of the atmoſphere, whether its component parts are to be conſidered merely as a mechanical mixture, or as a chemical combination. To the latter opinion the greater number of chemiſts are inclined, from the conſtancy of the proportions of the component parts of the atmoſphere, theſe parts always being found in the ſame proportion at all heights, and never ſeparating according to their ſpecific gravities; from its poſſeſſing diſtinct properties; and from its continuing the ſame, whatever proceſſes are carried on in it, or whatever proportions of oxygen may be abſorbed during theſe proceſſes.

362 or a mechanical mixture.

A contrary opinion has been adopted by Mr Dalton, which he has endeavoured to eſtabliſh by ſome very acute mathematical reaſoning. According to this ingenious hypotheſis, the elaſtic fluids which exiſt in the atmoſphere, have no mutual action whatever. The particles of one fluid are only attracted and repelled by each other, but are not acted upon by the particles of another fluid. The particles of the different fluids, with regard to each other, are ſubject to the laws of inelaſtic bodies[*].

SECT. II. *Of* NITROUS OXIDE GAS.

363 Proceſs for obtaining this gas.

1. This gas is moſt readily obtained by decompoſing nitrate of ammonia, a ſalt compoſed of nitric acid and ammonia, the properties of which will be afterwards particularly detailed. The cryſtals of this ſalt are put into a retort, and expoſed to a temperature between 340° and 500°. It very ſoon melts after the heat is applied, and a great quantity of gas is emitted, at firſt in the form of white fumes, but afterwards tranſparent and colourleſs. This may be received in jars over water in the uſual way. This is the nitrous oxide gas, the gaſeous oxide of azote, or, as it has been called by ſome, from the pleaſurable ſenſations it excites on being reſpired, *the gas of paradiſe*. The firſt part of the gas which comes over is not quite ſo pure as when it is given out ſlowly, and when it is tranſparent. When therefore it is reſpired, care ſhould be taken to ſeparate what comes off firſt, from the reſt. This gas, as is obvious from the proceſs, is obtained by the decompoſition of the nitrate of ammonia; but the change

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[*] *Annal. de Chim.* vol. xxxiv. p. 3.

[†] *Ibid.* vol. xxxv. p. 23.

[*] *Mancheſ. Mem.* vol. v. p 535.

(B) The component parts of water are oxygen and hydrogen, as we ſhall find afterwards.

which takes place will be better underſtood, when we come to treat of the ſalt itſelf, being previouſly acquainted with its conſtituent parts.

364 Diſcovery. 2. This gas was called by Dr Prieſtley dephlogiſticated nitrous gas; and it was diſcovered by him in the year 1776. Its component parts were aſcertained by the aſſociated Dutch chemiſts; but its nature and properties were more fully and preciſely inveſtigated by Mr Davy *.

365 Properties. 3. In its phyſical properties, this gas reſembles common air. It is elaſtic, tranſparent, and colourleſs. The ſpecific gravity, as it has been eſtimated by Mr Davy, is 0.00197. One hundred cubic inches of it weigh 50.20 grs. The component parts of nitrous oxide gas are 63 of azote, and 37 of oxygen gas.

Some combuſtibles burn in this gas nearly as well as in oxygen gas, but with this difference, that they muſt be in a ſtate of ignition.

Pyrophorus, which ſpontaneouſly inflames ſo low as the temperature of 40° in atmoſpheric air, will not burn in nitrous oxide gas, till it is raiſed to a temperature above 212°. A burning taper introduced into pure nitrous oxide gas, burns at firſt with a brilliant white light, and ſparkles as in oxygen gas; but as the combuſtion goes on, the flame gradually lengthens, and is ſurrounded with a pale blue light. Phoſphorus burns in it with a brilliancy not much inferior to its combuſtion in oxygen gas.

366 Effects in reſpiring it. 4. It was at firſt ſuppoſed that this gas is unfit for reſpiration, but the experiments of Mr Davy have ſhewn the contrary; and the ſingular effects which it produces on the animal frame have excited much intereſt. From theſe experiments, and from many others which have been ſince repeated, it appears that it may be reſpired for ſome minutes without injury. In ſome caſes it produces no effect whatever; but, in general, the ſenſations it excites are ſimilar to thoſe of intoxication; but they are rarely followed by its unpleaſant effects. Mr Davy deſcribes his own feelings when he reſpired this gas, in the following words.

"Having previouſly cloſed my noſtrils and exhauſted my lungs, I breathed four quarts of nitrous oxide from and into a ſilk bag. The firſt feelings were giddineſs, ſenſe of fullneſs of the head, and indiſtinct ſenſation; but in leſs than half a minute, the reſpiration being continued, they diminiſhed gradually, and were ſucceeded by a ſenſation analogous to gentle preſſure on all the muſcles, attended by a highly pleaſurable thrilling, particularly in the cheſt and the extremities. The objects around me became dazzling, and my hearing more acute. Towards the laſt inſpirations, the thrilling increaſed, the ſenſe of muſcular power became greater, and at laſt an irreſiſtible propenſity to action was indulged in; I recollect but indiſtinctly what followed; I know that my motions were various and violent.

"Theſe effects very ſoon ceaſed after reſpiration. In ten minutes I had recovered my natural ſtate of mind. The thrilling in the extremities continued longer than the other ſenſations.

"This experiment was made in the morning; no languor or exhauſtion was conſequent, my feelings throughout the day were as uſual, and I paſſed the night in undiſturbed repoſe *."

But although it may be reſpired for a ſhort time with impunity, not more than 3 or 4 minutes, yet animals that are confined in it ſoon become reſtleſs and uneaſy, and at laſt expire. From this therefore it appears that it is unfit for the ſupport of animal life, and perhaps could not at all be reſpired, if the lungs were previouſly exhauſted of atmoſpheric air.

367 Taſte and ſmell. 5. The taſte of nitrous oxide gas, when in a ſtate of purity, is diſtinctly ſweet to the tongue and palate; and it has an agreeable odour. Mr Davy obſerves, that he often thought it produced a feeling ſomewhat analogous, as he expreſſes it, to taſte in its application to the lungs; for in one or two experiments he perceived a diſtinct ſenſe of warmth in the cheſt †.

368 Is abſorbed by water. 6. Water abſorbs nitrous oxide gas in conſiderable porportion. When the water is agitated, 0.54 parts of its bulk, or 0.27 of its weight, combine with it. The water becomes ſweetiſh, and the whole of the gas may be expelled from it unchanged, by boiling.

7. No change takes place upon this gas by the action of light, but when it is expoſed to a high temperature, as when the electric ſpark is ſent through it, or when it is made to paſs through a red-hot porcelain tube, it is decompoſed, and converted into common air and nitric acid.

SECT. III. *Of Nitrous Gas.*

369 How procured. 1. If a quantity of pure copper filings be put into a matraſs or retort, and diluted nitric acid be poured over them, a violent efferveſcence takes place, and a great quantity of gas is evolved. This is *nitrous gas*. It may be obtained alſo, by ſubſtituting for the copper other metals, as iron, ſilver, and mercury.

This gas is mentioned by Dr Hales, but it is to the labours of Dr Prieſtley that we are indebted for the knowledge of its nature and properties.

370 Properties. 2. This gas is an elaſtic, colourleſs fluid, which has no ſenſible taſte, and does not redden the tincture of turnſole (c).

According to Mr Kirwan, the ſpecific gravity of nitrous gas is 0.001458, but by Mr Davy's eſtimation it is 0.001343. The weight of 100 cubic inches of it is 34.26 grs. and it is compoſed of 55.95 oxygen, and 44.05 azote ‡. This gas is totally unfit for reſpiration. Animals that breathe it are inſtantly ſuffocated.

Some combuſtibles burn in this gas. Phoſphorus, when introduced into it in a ſtate of active inflammation, burns with almoſt as much vividneſs as in oxygen gas ||. Homberg's pyrophorus, a ſubſtance which takes fire when expoſed to the air, when introduced into this gas, inſtantly becomes red, and burns very vividly. In this experiment, and in the former with the phoſphorus, theſe ſubſtances combine with the oxygen of the nitrous gas, while heat and light are emitted and azotic gas is left behind.

371 Action of heat. 3. Nitrous gas, when expoſed to the action of heat, by being made to paſs through a red-hot porcelain tube, undergoes

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* Reſearches. 1800.

* Davy's Reſearches, p. 457.

† Ibid. p. 460.

‡ Ibid. p. 365.

|| Ibid. p. 135.

(c) This is a teſt for acid ſubſtances, which will be mentioned particularly afterwards.

undergoes no change *. It is abſorbed by water. When the water is freed from air, it abſorbs about $\frac{1}{10}$ of its bulk of nitrous gas, at the common temperature, and when it is boiled or frozen, the gas ſeparates unchanged. The water thus impregnated with nitrous gas, has no peculiar taſte, nor does it alter the colour of vegetable blues.

372
Combines with oxygen.

4. When a quantity of atmoſpherical air is introduced into a jar containing nitrous gas, a red colour appears from the mixture of the two gaſes; they are diminiſhed in bulk, and heat is evolved. The product is nitrous acid. If oxygen gas be employed in place of atmoſpheric air, the whole of the two gaſes will be converted into a liquid. The diminution of bulk is owing to the condenſation of the elaſtic fluids, and the evolution of caloric muſt be aſcribed to the change of ſtate, from that of elaſtic fluid to that of liquid.

Azotic gas alſo enters into combination with oxygen in a different proportion from what has been ſtated above, forming nitrous and nitric acids; but theſe will come more properly to be treated of among the claſs of acids.

The following table exhibits at one view the different proportions of oxygen and azotic gaſes in the compounds formed by theſe two ſubſtances.

100 cubic inches.	Weight in grains.	In 100 grains, Proportions of	
		Azote.	Oxygen.
Atmoſpheric air	31.10	73.00	27.00.
Nitrous oxide	50.20	63.30	36.70
Nitrous gas	34.26	44.05	55.95
Nitric acid	76.00	29.50	70.50

CHAP. VI. OF HYDROGEN GAS.

373
Hiſtory.

1. THIS gas has been long known under the name of the *fire-damp* of the miners. Its combuſtible property is deſcribed in the works of Boyle and Hales, of Boerhaave, and of Stahl; but it was not till the year 1766 that its properties were particularly aſcertained, and the difference between it and atmoſpheric air pointed out by Mr Cavendiſh. Its properties and combinations were more fully inveſtigated by Prieſtley and Scheele, Senebier and Volta, under the name of *inflammable gas* or *air*. It is now diſtinguiſhed by the name of hydrogen gas, and its baſe by that of hydrogen.

Like the two former, oxygen and azote, it is never obtained in an uncombined ſtate. Its properties can only be examined in a ſtate of gas.

374
Method of procuring.

2. Hydrogen gas may be obtained in a ſtate of tolerable purity by the following proceſs. Take one part of clean iron filings, and introduce them into a tubulated retort, and add two parts of ſulphuric acid previouſly diluted with four times its bulk of water. A violent efferveſcence immediately takes place, and great abundance of air bubbles make their eſcape. Put in the ſtopper of the retort, and place the beak of it under the ſhelf in the pneumatic trough, and let the gas which comes over be received in proper veſſels. The gas which is thus obtained, is *hydrogen gas*, which is diſtinguiſhed by the following properties.

3. In its phyſical properties it reſembles common air. It is inviſible and elaſtic, and may be indefinitely compreſſed and expanded.

375
Properties.

Its ſpecific gravity has been variouſly eſtimated, owing, perhaps, to its different degrees of purity. According to Lavoiſier, it is 2.000094, which is nearly 12 times lighter than atmoſpherical air; but, according to Mr Kirwan, it is 0.00010.

Hydrogen gas is unfit for ſupporting combuſtion. If a lighted candle be ſuddenly plunged in a veſſel filled with hydrogen gas, it is immediately extinguiſhed; or if an inverted jar filled with hydrogen gas be ſuddenly brought over a lighted candle, it is extinguiſhed in the ſame way. The latter experiment is the moſt effectual, on account of the ſmall ſpecific gravity of the hydrogen gas, which is prevented from eſcaping by riſing upwards when the jar is inverted.

It is alſo unfit for reſpiration.

When ſmall animals are encloſed in a veſſel filled with this gas, they are ſoon thrown into convulſions, and expire. Scheele, however, who firſt made the attempt, breathed it ſeveral times without much injury. Fontana made the ſame experiment, and he ſuppoſes that this was owing to the common air in the lungs before reſpiration of the hydrogen gas; for when he made a full expiration, before he began to breathe the hydrogen gas, he could only inſpire it three times, and theſe three produced great languor and oppreſſion about the breaſt. This is confirmed by Mr Davy of the royal inſtitution, who, in ſome experiments on himſelf found, that, after having exhauſted the lungs as much as poſſible, he could not reſpire this gas for half a minute. It produced uneaſy feelings in the cheſt, momentary loſs of muſcular power, and ſometimes a tranſient giddineſs *. From theſe experiments, therefore, it may be concluded, that hydrogen gas is totally incapable of ſupporting animal life.

376
Is combuſtible.

4. But although hydrogen gas be unfit for the ſupport of combuſtion, or for reſpiration, yet it is itſelf a highly combuſtible ſubſtance. If a jar be filled with hydrogen gas, and a burning taper be applied, the gas will take fire, and burn with a flame which is more or leſs coloured according to the purity of the gas. When the gas is in the pureſt ſtate that can be obtained, it is of a white colour; but when it holds charcoal in ſolution, it is of a reddiſh colour.

377
Combines with water only by preſſure.

5. Hydrogen gas, if other gaſes be entirely excluded, undergoes no change when it is kept in contact with water, nor is any part of it abſorbed by the water: But when artificial preſſure is employed, water is ſaid to abſorb a third part of its bulk of the gas.

378
A remedy in diſeaſe.

No perceptible change is obſerved in the taſte of the water thus impregnated with hydrogen gas; it is recommended by Mr Paul as beneficial in nervous diſorders, and in inflammatory fevers †.

379
Employed in balloons.

Hydrogen gas, on account of its being ſo much lighter than atmoſpherical air, has been employed for the purpoſe of filling air balloons. When perfectly pure, it is 12 or 13 times lighter than the ſame bulk of atmoſpherical air; but, in the uſual way of obtaining it, the ſpecific gravity of hydrogen gas is ſeven or eight times leſs than that of common air. See AEROSTATION.

380
Explodes

6. If hydrogen gas and atmoſpherical air be mixed together, they remain unaltered; but if one part of oxygen

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* *Lagrange*, vol. i. p. 122.

* *Davy's Reſearches*, p. 401.

† *Phil. Mag.* v. xv p. 93.

gen gas, and two parts of hydrogen gas, be introduced into a phial, and a burning taper be applied to its mouth, the mixed gaſes will explode with a loud noiſe, and the bulk will be greatly diminiſhed. The whole of the oxygen of the atmoſpheric air diſappears, and the azotic gas only remains. If one part of oxygen gas and 2½ parts of hydrogen gas be mixed together in a phial, and exploded in the ſame way, they both diſappear. This may be proved by mixing the two gaſes in a jar over water or mercury, and exploding them by means of the electric ſpark. The gaſes diſappear; a vacuum is conſequently formed in the jar, and the water or the mercury, by the preſſure of the air, is forced up. If the experiment has been made over mercury, and if the inſide of the jar was previouſly free from moiſture, drops of water will appear, which have been formed by the combination of the two gaſes. Water, therefore, is compoſed of oxygen and hydrogen gas. This is a caſe of true combuſtion. Oxygen combines with the combuſtible body; light and caloric are evolved, and the reſult of this action and combination is one of the products of combuſtion, namely water. The diſcovery of the compoſition of water, undoubtedly one of the moſt important in modern chemiſtry, will be the ſubject of the following ſection.

351 With atmoſpheric air

352 And with oxygen gas.

Sect. I. *Of Water.*

383 Importance in chemiſtry.

1. Water acts ſo important a part in many chemical actions and combinations, that its nature and properties ſhould be early known. Before the diſcoveries of modern chemiſtry, it was conſidered as a ſimple ſubſtance, and one of the four elements which enter into the conſtitution of all bodies in nature.

The fortunate diſcovery of the compoſition of water, is undoubtedly one of the moſt important which has been made in chemical ſcience. We have already mentioned, that the product of oyxgen and hydrogen gaſes, when exploded together, is water (d): but in a ſubject of ſo much importance, it will be neceſſary to enter more into detail; and this we ſhall do, 1ſt, by ſtating the experiments on the baſis of which the proofs of its compoſition reſt; and 2dly, by giving a ſhort hiſtorical view of the progreſs of the diſcovery.

2. Various experiments have been made to aſcertain this fact; but thoſe which were made by Lavoiſier being on a larger ſcale, and performed with ſuch precautions as to inſure accuracy and preciſion, the following account of them will be the more ſatisfactory.

1. *Proof of the Compoſition of Water.*

384 Proof of the compoſition of water by analyſis.

Exper. a. Take a porcelain or glaſs tube from 8 to 12 lines diameter, and place it acroſs the furnace EFCD, with a gentle inclination from E to F (e). The higher extremity of the tube is then luted to the glaſs retort A, containing a known quantity of diſtilled water. To the lower extremity F is luted the worm SS, the lower end of which is fixed in the neck of the bottle H, which bottle has the bent tube KK fixed to a ſecond opening. This bent tube is intended to carry off any elaſtic fluids which may eſcape into the bottle H. A fire is then lighted in the furnace EFCD, ſufficient to keep the tube EF red hot, but not to melt it. The water in the retort A is kept boiling by a fire in the furnace VVXX. The water is gradually changed into ſteam by the heat of the two furnaces. It paſſes through the tube EF into the worm SS, where it is condenſed, and then drops into the bottle H. When the whole water is evaporated, and all the communicating veſſels are emptied into the bottle H, it is found to contain exactly the ſame quantity which was put into the retort. This experiment therefore is a ſimple diſtillation.

Plate XLII. Fig. 3.

Exper. b. Every thing being diſpoſed as in the laſt experiment, let 28 grains of pure charcoal, broken into ſmall parts, and which has been expoſed to a red heat in a cloſe veſſel, be introduced into the tube EF. The experiment is then performed in the ſame manner as the former. The water is evaporated, and a portion of it is again condenſed in the worm SS, and then falls into the bottle H; but at the ſame time a conſiderable quantity of an elaſtic fluid eſcapes through the tube KK, which is received in veſſels. When the water is entirely evaporated, and the tube examined, the 28 grains of charcoal have wholly diſappeared.

When the water in the bottle H is examined it is found to have loſt 85.7 grains of its weight; and when the elaſtic fluid which paſſed off by the tube KK is weighed, it is found to weigh 113.7 grains, which is exactly the weight which the water has loſt, added to the 28 grains of charcoal which had diſappeared. The elaſtic fluid, on examination, is diſcovered to be of two kinds; namely, 144 cubical inches of carbonic acid gas weighing 100 grains, and 380 cubical inches of a very light gas weighing only 13.7 grains. Now 100 grains of carbonic acid gas conſiſt of 72 grains of oxygen, combined with 28 grains of carbone. It is therefore evident, that the 28 grains of charcoal muſt have acquired 72 grains of oxygen from the water. It is alſo evident, that 85.7 grains of water are compoſed of 72 grains of oxygen, combined with 13.7 grains of a gas capable of being burned.

Exper. c. Every thing being put in the ſame order as in the two former experiments, with this difference, that inſtead of the 28 grains of charcoal, 274 grains of ſoft iron, in thin plates rolled up ſpirally, are introduced into the tube EF. The tube is kept red hot while the water is evaporating from the retort.

(d) Sir Iſaac Newton having diſcovered in the courſe of his optical inveſtigations, that combuſtible bodies poſſeſs the greateſt refractive power in proportion to their denſity, and obſerving the great refracting power of water, conjectured with aſtoniſhing ſagacity that it muſt contain a combuſtible ſubſtance. In the ſame way he was led to a ſimilar conjecture with regard to the diamond; both which have been verified.

(e) The tube EF, if of glaſs, ſhould be ſuch as can bear a ſtrong heat without melting. It ſhould alſo be coated over with a lute compoſed of clay and powdered ſtone-ware; and to prevent it from bending during the experiment, it muſt be ſupported about the middle by an iron bar.

After the water has been diſtilled, it is found to have loſt 100 grains. The gas or elaſtic fluid weighs 15 grains, and the iron has gained 85 grains additional weight, which put together make up 100 grains, the weight which the water has loſt. The iron has all the qualities which it would have received by being burned in oxygen gas. It is a true oxide (or calx) of iron. We have the ſame reſult as in the laſt experiment, and have therefore another proof for concluding, that 100 grains of water conſiſt of 85 grains of oxygen, and 15 of the baſe of inflammable gas.

385 Proved by ſyntheſis.

We have now exhibited two ſufficient proofs, that water is compoſed of oxygen and hydrogen; but as the compoſition of water is ſo intereſting and important a ſubject, M. Lavoiſier was not ſatisfied with theſe proofs alone. He juſtly concluded, that if water be a compound of two ſubſtances, it ought to follow, that by reuniting theſe two ſubſtances, water would be produced. He accordingly proved the truth of this concluſion by the following experiment.

Exper. d. He took a large cryſtal balloon A, fig. 4. containing about 30 pints, and having a large mouth; round which was cemented the plate of copper BC, pierced with four holes, through which four tubes paſs. The firſt tube H *h*. is intended to exhauſt the balloon of its air, by adapting it to an air pump. The ſecond tube *g g* communicates with a reſervoir of oxygen gas placed at MM. The third tube *d* D δ is connected with a reſervoir of hydrogenous gas at NN. The fourth tube contains a metallic wire GL, having a knob at its lower extremity L, from which an electric ſpark is paſſed to δ, in order to ſet fire to the hydrogen gas. The metallic wire is moveable in the tube, that the knob L may be either turned towards δ, or away from it, as there is occaſion. We muſt alſo add, that the three tubes H *h*, *g g*, *d* D δ are furniſhed with ſtopcocks.

It is neceſſary that the oxygen gas, before being put into the reſervoir, ſhould be completely purified from carbonic acid. This may be done by keeping it for a long time in contact with a ſolution of cauſtic potaſh. The hydrogen gas ought to be purified in the ſame manner. The quantity employed ought to be double the bulk of the oxygen gas. It is beſt procured from water by means of iron, as was deſcribed in Experiment Third.

Great care muſt alſo be taken to deprive the oxygen and hydrogen gas of every particle of water. For this purpoſe they are made to paſs in their way to the balloon A, though ſalts which have a ſtrong attraction for water; as the acetite of potaſh (a compound of vinegar and vegetable alkali), or the muriate or nitrate of lime (the muriatic or nitric acid combined with lime). Theſe ſalts are diſpoſed in the tube MM and NN of one inch diameter, and are reduced only to a coarſe powder, that they may not unite into lumps, and interrupt the paſſage of the gaſes.

Every thing being thus prepared for the experiments, the balloon is exhauſted of its air by the tube H *h*, and is filled with oxygen gas. The hydrogen gas is alſo preſſed in through the tube *d* D δ by a weight of one or two inches of water. As ſoon as the hydrogen gas enters the balloon, it is ſet fire to by an electric ſpark. The combuſtion can be kept up as long as we pleaſe, by ſupplying the balloon with freſh quantities of theſe two gaſes. As the combuſtion advances, a quantity of water is collected on the ſides of the balloon, and trickles down in drops to the bottom of it. By knowing the weight of the gaſes conſumed, and the weight of the water produced, we ſhall find that they are preciſely equal. M. Lavoiſier and M. Meuſnier found that it required 85 parts by weight of oxygen gas, and 15 parts of hydrogen gas, to produce 100 parts of water.

Thus we have complete proofs, both analytical and ſynthetical, that water is not a ſimple elementary ſubſtance, as it has been long ſuppoſed, but is compounded of two elements, oxygen and hydrogen.

But although the knowledge of the component parts of water was finally confirmed by Lavoiſier and his friends, we ſhall find that ſcience is indebted for its origin and progreſs, chiefly, if not entirely, to the Engliſh philoſophers.

2. *Hiſtory of the Diſcovery of the Compoſition of Water.*

386 Combuſtion of hydrogen yields water.

1. So early as the year 1776, an experiment was made by Macquer, to aſcertain what would be the product of the combuſtion of hydrogen gas. He accordingly ſet fire to a bottle full of it, and held a ſaucer over the flame, but no ſoot appeared upon it as he expected, for it remained quite clean; and was bedewed with drops which were found to be pure water. Various conjectures were now formed about the nature of the product of the combuſtion of oxygen and hydrogen gaſes. By ſome it was ſuppoſed the carbonic acid gas; by others it was conjectured it would be the ſulphurous or ſulphuric acid. The latter was the opinion of M. Lavoiſier. Such were the experiments and opinions of the French chemiſts, previous to the year 1781.

387 Conjectures.

388 Experiment by Warltire and Prieſtley.

2. About the beginning of that year, Mr Warltire, a lecturer in natural philoſophy, had long entertained an opinion that the combuſtion of hydrogen gas with atmoſpheric air might determine the queſtion, whether heat be a heavy body. Apprehenſive of danger in making the experiment, he had for ſome time declined it; but was at laſt encouraged by Dr Prieſtley, and accordingly prepared an apparatus for the purpoſe. This was a copper veſſel properly fitted, and filled with atmoſpherical air and hydrogen gas, which was exploded by making the electric ſpark paſs through it. A loſs of weight of two grs. was obſerved after the combuſtion. A ſimilar experiment was repeated in cloſe glaſs veſſels, which, though clean and dry before the combuſtion, became immediately wet with moiſture, and lined with a ſooty matter. This ſooty matter, Dr Prieſtley afterwards ſuppoſed, proceeded from the mercury which had been employed in filling the veſſel.

389 By Cavendiſh.

3. During the ſame year, Mr Cavendiſh repeated the experiments of Mr Warltire and Dr Prieſtley. He performed them ſeveral times with atmoſpheric air and hydrogen gas, in a veſſel which held 24,000 grs. of water, and he never could perceive a loſs of weight more than $\frac{1}{2}$ gr. and often none at all. In all theſe experiments, not the leaſt ſooty matter appeared in the inſide of the glaſs. To examine the nature of the dew which appeared in the inſide of the glaſs, he burnt 500,000 grain meaſures of hydrogen gas with about $2\frac{1}{2}$ times that quantity of common air; and in this com-

buſtion he obtained 135 grs. of water, which had neither taſte nor ſmell; and when it was evaporated, left no ſenſible ſediment. It ſeemed to be pure water.

In another experiment, he exploded in a glaſs globe, 19,500 grain meaſures of oxygen gas, and 37,000 of hydrogen gas, by means of the electric ſpark. The reſult of the experiment was 30 grains of water, which contained a ſmall quantity of nitric acid. The experiments of Mr Cavendiſh were made in the year 1781, and they are undoubtedly concluſive with regard to the compoſition of water.

390 Mr Watt's views.

4. It would appear, that Mr Watt entertained the ſame ideas on this ſubject. When he was informed by Dr Prieſtley of the reſult of theſe experiments, he obſerves; "Let us conſider what obviouſly happens in the deflagration of hydrogen and oxygen gaſes. Theſe two kinds of air unite with violence, they become red hot, and when cooling totally diſappear. When the veſſel is cooled, a quantity of water is found in it equal to the weight of the air employed. The water is then the only remaining product of the proceſs; and water, light, and heat are all the products, unleſs there be ſome other matter ſet free, which eſcapes our ſenſes. Are we not then authorized to conclude, that water is compoſed of oxygen and hydrogen gaſes, deprived of part of their latent or elementary heat; that oxygen gas is compoſed of water, deprived of its hydrogen, and united to elementary heat and light; and that the latter are contained in it in a latent ſtate, ſo as not to be ſenſible to the thermometer or to the eye. And if light be only a modification of heat, or a circumſtance attending it, or a component part of the hydrogen gas, then oxygen gas is compoſed of water deprived of its hydrogen, and united to elementary heat."

Phil. Tranſ. 1784, p. 383.

Thus it appears that Mr Watt had a juſt view of the compoſition of water, and of the nature of the proceſs by which its component parts paſs to a liquid ſtate from that of an elaſtic fluid.

391 Lavoiſier's experiments.

5. Towards the end of the ſame year, M. Lavoiſier had made ſome experiments, the reſult of which ſurpriſed him; for the product of the combuſtion of the oxygen and hydrogen gaſes, inſtead of being ſulphuric or ſulphurous acid, as he expected it, was pure water. This led him to procure an apparatus, with which the experiment might be performed on a large ſcale, and with more accuracy and preciſion. Accordingly the experiments which we have already detailed were performed on the 24th of June 1783, in preſence of ſeveral academicians, and alſo of Sir Charles Blagden, who was at that time in Paris. A ſimilar experiment was afterwards performed by M. Monge, with the ſame reſult; and it was repeated again by Lavoiſier and Meuſnier, on a ſcale ſo large as to put the matter beyond a doubt. The concluſion, therefore, from the whole was (as has been ſtated in detailing the experiments themſelves), that water is compoſed of oxygen and hydrogen; and this fact, we believe, ſince Dr Prieſtley's death, is univerſally admitted.

392 Fourcroy's, &c.

6. If farther proofs were neceſſary to eſtabliſh the fact, we might refer the reader to an elaborate memoir on the combuſtion of hydrogen gas in cloſe veſſels by the celebrated chemiſts Fourcroy, Vauquelin, and Seguin, which was read at the academy of ſciences in the year 1790 *.

393 Water in three ſtates.

7. Water exiſts in three different ſtates; in the ſolid ſtate or ſtate of ice; in the liquid, and in the ſtate of vapour or ſteam. Its principal properties have already been detailed, in treating of the effects of caloric. It aſſumes the ſolid form when it is cooled down to the temperature of 32°. In this ſtate it increaſes in bulk, by which it exerts a prodigious expanſive force, which is owing to the new arrangement of its particles, which aſſume a cryſtalline form, the cryſtals croſſing each other at angles of 60° or 120°. The ſpecific gravity of ice is leſs than that of water. 394 Ice.

395 Water or liquid.

When ice is expoſed to a temperature above 32°, it abſorbs caloric, which then becomes latent, and is converted into the liquid ſtate, or that of water. At the temperature of 42½°, water has reached its maximum of denſity. According to the experiments of Lefevre Gineau †, a French cubic foot of diſtilled water, taken at its maximum of denſity, is equal to 70lb. 223 grs. French, = 529,452.9492 troy grains. An Engliſh cubic foot at the ſame temperature weighs 437,102.4946 grains troy. By Profeſſor Robiſon's experiments it is aſcertained, that a cubic foot of water at the temperature of 55° weighs 998.74 avoirdupois ounces, of 437.5 grains troy each, or about 1¼ ounce leſs than 1000 avoirdupois ounces.

396 Vapour.

When water is expoſed to the temperature of 212°, it boils, and if this temperature be continued, the whole is converted into an elaſtic inviſible fluid, called vapour or ſteam. This, as has been already ſhewn, is owing to the abſorption of a quantity of caloric, which is neceſſary to retain it in the fluid form. In this ſtate it is about 1800 times its bulk when in the ſtate of water. This ſhews what an expanſive force it muſt exert when it is confined, and hence its application in the ſteam engine, of which it is the moving power.

Sect. II. *Of Ammonia.*

Hydrogen alſo enters into combination with azote, and forms a compound of great importance. When hydrogen and azotic gaſes are mixed together, no change takes place, nor has any proceſs been yet diſcovered by which theſe two gaſes can be directly combined; but when theſe are in their naſcent ſtate, as it is called, or in the moment of evolution from the bodies with which they were formerly in combination, they unite together and form ammonia, or the volatile alkali. It is demonſtrated alſo by direct experiment, that this ſubſtance is compoſed of theſe two gaſes; but for the properties of it, we muſt refer to the chapter on alkalies, where they will be fully detailed.

Chap. VII. Of CARBONE.

397 The diamond combuſtible.

1. It may appear at firſt ſight ſurpriſing, that the diamond, one of the hardeſt and moſt indeſtructible ſubſtances in nature, ſhould be arranged among combuſtible bodies. This, however, was conjectured by Newton, when he conſidered its great refracting power, referring it to the general law, that combuſtible bodies have this power in greateſt perfection. The ſagacious

conjecture

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* *Annal. de Chim.* vol. viii. p. 230.

† *Journ. de Phyſ.* tom. xlix. p. 171.

398 Proved by experiment.

conjecture of this great philoſopher has been fully verified. The firſt experiment to aſcertain the combuſtibility of the diamond, was made in the year 1694, in the preſence of Coſmo III. grand duke of Tuſcany, by the Florentine academicians. In this experiment, the diamond, expoſed to the heat of a burning-glaſs, firſt became dull and tarniſhed, loſt of its weight, and was at laſt entirely diſſipated, without the ſmalleſt reſidue. Some years afterwards, a ſeries of experiments was made before Francis I. emperor of Germany, in which diamonds were conſumed in the heat of a furnace. In the year 1771, Macquer firſt obſerved the diamond ſwell up and burn with a very ſenſible flame. Rouelle the younger, Cadet, Mitouart, and Darcet, repeated the ſame experiments, all which tended to eſtabliſh the volatility and combuſtibility of the diamond.

But it is to the celebrated Lavoiſier that we are indebted for aſcertaining the nature and product of this combuſtion.

399 Found in the torrid zone.

2. But for the ſake of compariſon, we ſhall mention ſome of the general properties of the diamond. This precious ſtone is found in the warmer regions of the earth, and chiefly in the Eaſt Indies and the Brazils. It is found cryſtallized in regular octahedrons, which is its primitive form; that of the molecules is the regular tetrahedron. The moſt common form is the ſix-ſided priſm, terminating in a ſix-ſided pyramid. What are called ſpheroidal diamonds, have 48 curvilineal, triangular faces, which form of cryſtal is owing, according to Hauy, to a regular decrement, which may be determined by calculation. The lapidaries are well acquainted with the direction of the laminæ of the diamond, becauſe in that direction it is found to be moſt eaſily poliſhed. The hardeſt diamonds are found to have their fibres twiſted, which by the lapidaries are called *natural* diamonds.

400 Form.

401 Properties.

3. The diamond is the hardeſt body known. It can only be poliſhed with the powder of itſelf, which is procured by rubbing one diamond againſt another. The ſpecific gravity of the diamond is 3.5. One of its moſt remarkable properties is its brilliancy. When expoſed to the light of the ſun for ſome time, and afterwards carried into a dark place, it appears luminous, ſo that it has the property of abſorbing light. It becomes very ſenſibly electric by friction, and is therefore a nonconductor of electricity.

402 Product of its combuſtion.

4. As it was now aſcertained, that the diamond expoſed to a ſtrong heat was ſuſceptible of combuſtion, and might be entirely diſſipated, Lavoiſier directed his attention in the year 1772 to diſcover the product which was thus obtained; and he found by experiment, that the quantity of the diamond, expoſed to the heat of a burning-glaſs in oxygen gas, conſumed, was in exact proportion to the quantity of air which was abſorbed. The air was converted into carbonic acid gas (F). The quantity of the carbonic acid obtained being found proportional to the quantity of diamond conſumed, it was concluded that diamond was nothing elſe but pure carbone. This furniſhed a ſtriking analogy between the diamond and charcoal, from the combuſtion of which a ſimilar product is obtained. An experiment made by Guyton in the year 1785, and a ſimilar one repeated in 1797 by Mr Tennant, proved that the diamond is combuſtible, and that it burns like charcoal when thrown into melted nitre. The concluſion from which was, that the diamond and charcoal are compoſed of the ſame ſubſtance.

403 A ſimple ſubſtance.

5. We ſhall find in inveſtigating the properties of charcoal in the following ſection, that the one is a ſimple, the other a compound ſubſtance, which will enable us to explain the remarkable difference between many of the properties of the diamond and charcoal. Charcoal burns in the heat of an ordinary fire, but the diamond requires for its combuſtion a temperature not leſs than 5000°; nor is the difference between theſe two bodies in ſpecific gravity, hardneſs, and colour, leſs ſtriking. Lavoiſier had aſcertained that 100 parts of carbonic acid contained

404 Compared with charcoal, which is a compound.

28 charcoal,
72 oxygen.
100

In the experiments made by Guyton on the diamond, it appeared that carbonic acid gas is compoſed of

17.88 diamond,
82.12 oxygen.
100.00*.

If then 100 parts of carbonic acid gas are compoſed of the ſame proportions of conſtituent parts, and theſe proportions are obtained both by the combuſtion of the diamond and charcoal, it muſt neceſſarily follow that the charcoal, which requires a ſmaller proportion of oxygen to make up the 100 parts of carbonic acid gas, muſt contain the difference of the quantity of oxygen between the quantity with which it combines, and the quantity neceſſary to ſaturate the diamond. Thus, diamond requires 82.12 of oxygen, and charcoal requires only 72, the difference between which is 10.12, which muſt have been previouſly combined with the charcoal before combuſtion. The 28 parts of charcoal, then, are compoſed of

17.88 diamond,
10.12 oxygen.
28.00

Hence it follows, that 100 parts of charcoal conſiſt of

63.86 diamond,
36.14 oxygen.
100.00

From this account, therefore, of the nature and properties of the diamond, it muſt be conſidered as a ſimple ſubſtance, and that ſubſtance which has received the name of carbone in the new chemical nomenclature; very different in its properties from charcoal, which is a compound ſubſtance, and has received the name of oxide

* *Ann. de Chim.* tom. xxxi. p. 99.

(F) Carbonic acid gas, as will appear afterwards, is compoſed of carbone and oxygen.

oxide of carbone or diamond (G). But we ſhall conſider the properties of the compound more particularly in the following ſection.

Sect. I. *Of the Combinations of Carbone with Oxygen.*

Carbone enters into combination with oxygen. 1. In the ſtate of charcoal or *oxide of carbone;* 2. In the form of gas, which has been denominated the *gaſeous oxide of carbone*, or *carbonic oxide;* and 3. In another proportion, conſtituting *carbonic acid*, which alſo exiſts in the gaſeous ſtate. The nature and properties of the two firſt we are now to examine: the laſt will be treated of under the claſs of acids.

I. Of Charcoal.

405 Charcoal very abundant.

1. Charcoal exiſts in great abundance in animal and vegetable matters, and it is obtained by the partial decompoſition of theſe ſubſtances. It may be procured by burning wood in cloſe veſſels; and the matter that remains after this combuſtion, is a black, ſhining, brittle ſubſtance, which is well known under the name of charred wood, or charcoal. 406 Method of preparing and purifying. To obtain charcoal pure, it muſt be repeatedly waſhed with pure water, and be afterwards expoſed for ſome time to a ſtrong heat in cloſe veſſels. Thus prepared, if it be entirely deprived of moiſture and excluded from air, it may be expoſed to the ſtrongeſt heat without any change.

407 Properties.

2. Charcoal is a good conductor of electricity. When it is new made, it is found to have the property of removing the diſagreeable odour with which animal matters beginning to putrify, clothes and other ſubſtances, are tainted. On account of this property, perhaps, and alſo on account of its mechanical effects, it is greatly recommended as an excellent teeth powder. Charcoal ſeems to be quite indeſtructible. This is the beſt method of preſerving wood from decay, which is expoſed to the effects of air and moiſture. Stakes charred on the outſide, have remained in the ground for ſome thouſand years, and are ſtill in perfect preſervation. This ſeems to have been a common practice among the ancients.

3. Charcoal has neither taſte nor ſmell. It is inſoluble in water, but it abſorbs moiſture in conſiderable proportion. When it is well dried, charcoal attracts the air very greedily. A piece of charcoal well dried, placed under a jar over mercury, abſorbs the air, and the mercury aſcends rapidly; but if a little water be introduced into the jar, the charcoal abſorbs the moiſture, gives out the air, and the mercury deſcends. In ſome experiments made with this view, it appeared that charcoal abſorbed four times its bulk of air; and when the charcoal was plunged into water, a fifth part of this air was diſengaged, which being examined, a quantity of oxygen had diſappeared. In another experiment, the charcoal was introduced into a veſſel filled with oxygen gas, when it abſorbed eight times its bulk of the gas, and being plunged into water, gave out a fourth part. Theſe experiments were made by Delametherie [*].

The experiments of Senebier ſeem to prove, that it was only the oxygen gas of the atmoſpheric air that was abſorbed by charcoal; but it has been ſince demonſtrated, that this only takes place when the charcoal is hot. The atmoſpheric air is abſorbed unchanged when the charcoal is cold.

4. When the temperature of pure charcoal is raiſed to redneſs, and if it be then introduced into a jar of oxygen gas, it burns rapidly, giving out brilliant ſparks, but with little flame. The charcoal diſappears, and the oxygen gas is totally changed. By its combination with the charcoal during the combuſtion, it is converted into a peculiar gas which has received the name of *carbonic acid gas*, the component parts of which were diſcovered by M. Lavoiſier, to be

28 charcoal,
72 oxygen.
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100

The properties of this acid will be fully deſcribed in its place among the claſs of acids.

5. It is generally agreed among chemiſts, that charcoal conſiſts of oxygen and carbone; but a controverſy at preſent exiſts, whether hydrogen does not, in all caſes, enter into its compoſition? 408 Compoſition. Charcoal prepared in the common way, always contains a portion of hydrogen. It is therefore to be conſidered as a triple compound, conſiſting of carbone, oxygen, and hydrogen. But according to the experiments of Deſormes and Clement, charcoal expoſed for ſome time in a cloſe veſſel to a very ſtrong heat, is entirely deprived of its hydrogen [†]. This, however, does not correſpond with the experiments of Mr Cruickſhank, in which the gaſes obtained from charcoal in all ſtates of preparation were always found to contain hydrogen.

6. There is no direct action between carbone and azotic gas; but by the action of a third ſubſtance. Compounds of azote, hydrogen and carbone, which are combined alſo with a greater or leſſer proportion of oxygen, frequently exiſt among vegetable and animal matters.

II. Of the Gaſeous Oxide of Carbone.

409 Hiſtory.

1. A peculiar inflammable gas, which has been conſidered of the ſame nature with the carbonated hydrogen gas to be deſcribed in the next ſection, was announced by Dr Prieſtley, from the manner of its production and properties, as a confirmation of the truth of the phlogiſtic theory. His experiments were ſoon repeated by many other chemiſts, and particularly by Mr Cruickſhank of Woolwich, who publiſhed a very ſatisfactory account of the nature, compoſition and properties of this gas. He gave it the name of the *gaſeous oxide of carbone.* He conſidered it as conſiſting of carbone united with oxygen; the oxygen and carbone exiſting in it being nearly in the proportion of two

[*] *Journ de Phyſ.* vol. xxv.

[†] *Annal. de Chim.* vol. xxxix. p. 29.

(G) In the preſent nomenclature of chemiſtry, the word *oxide* is uſed to denote the combination of oxygen with a baſe, the product of which combination exhibits no acid properties, as in the preſent caſe, the combination of oxygen with carbone or diamond.

410 Methods of procuring.

two to one. Dr Prieſtley obtained it from the gray oxide, or forge ſcales of iron and charcoal. Mr Cruickſhank alſo obtained it by a ſimilar proceſs. He employed the oxides of zinc and copper; the black oxide of manganeſe and litharge. The gas which is obtained from theſe ſubſtances, is a mixture of carbonic acid and the gaſeous oxide of carbone. Mr Cruickſhank found, that the oxides which moſt readily part with their oxygen, afford the greateſt proportion of carbonic acid; but the oxides which retain their oxygen more ſtrongly, give the greateſt proportion of the gaſeous oxide of carbone. At the beginning of the proceſs, carbonic acid comes over in greateſt abundance; it then diminiſhes, and afterwards nothing but the gaſeous oxide is extricated.

It is alſo obtained by expoſing to a ſtrong heat one part of pure charcoal and three parts of carbonate of lime, ſtrontites, or barytes, in an iron retort. The carbonic acid which is in combination with the earths, is partly diſengaged unchanged, and partly decompoſed by the charcoal, and converted by the action of the charcoal into the gaſeous oxide of carbone. The gas which is obtained in this proceſs is compoſed of one part of carbonic acid and five parts of gaſeous oxide [*]. The ſame gaſes are alſo obtained, by employing iron filings with the earthy carbonates, and the quantity is conſiderably increaſed when pure iron is uſed. Mr Cruickſhank and the French chemiſts alſo obtained it, by making carbonic acid gas paſs through red-hot charcoal, in an iron or porcelain tube. The carbonic acid is decompoſed, and the gaſeous oxide is formed.

The carbonic acid which is mixed with the gaſeous oxide obtained in all theſe proceſſes, may be ſeparated by waſhing the gas with lime water, and the gaſeous oxide remains in a ſtate of purity.

411 Properties.

2. This gas is inviſible and elaſtic like common air. Its ſpecific gravity is 0.001167; 100 cubic inches weigh 30 grains.

It is unfit for reſpiration. Small animals introduced into it are inſtantaneouſly ſuffocated; and in ſome perſons who attempted to breathe it, it produced faintneſs and giddineſs. Deſormes and Clement think that it is probably owing to this gas diſengaged from burning charcoal, that ſudden death is induced in cloſe apartments. It is not altered by paſſing it through a red-hot tube, nor does it undergo any change by being expoſed to light; and it is neither inflamed nor diminiſhed by paſſing the electric ſpark through it. This gas in contact with common air, when ſet fire to, burns with a blue flame. When it is made to traverſe a red-hot tube full of air, it produces ſlight detonations. The reſidue of theſe combuſtions is carbonic acid and azote.

3. With oxygen gas, if in conſiderable proportion, the combuſtion is very rapid; a red flame is produced, and the whole of the gas is conſumed. The reſidue in this combuſtion is carbonic acid [†].

According to Mr Cruickſhank, the gaſeous oxide of carbone is a compound of carbone and oxygen. Thirty grains of it obtained from charcoal and metallic oxides, required 15 grains of oxygen to ſaturate it, and the quantity of carbonic acid produced was 35.5. Thirty grains obtained from iron filings and earthy carbonate, required 13.6 grains of oxygen, which gave 43.2 grains of carbonic acid.

4. But according to the experiments and concluſions of Berthollet, the gaſeous oxides of carbone contain a certain portion of hydrogen in their compoſition. This quantity, he thinks, amounts to about .04=$\frac{1}{25}$. He diſtinguiſhes two ſpecies of inflammable gas, which contain carbone; the one conſiſts entirely of hydrogen and carbone, which he propoſes to denominate *carbonated hydrogen gas*, which will be treated of in the next ſection. The other ſpecies of inflammable gas is alſo formed of hydrogen and carbone, but contains a certain portion of oxygen. To this he propoſes to give the name of oxycarbonated hydrogen gas. But the reſults of the experiments of Cruickſhank and others do not correſpond with the experiments and concluſions of Berthollet, in admitting any proportion of hydrogen as a component part of his oxycarbonated hydrogen gas, or of the gaſeous oxide of carbone. But for an account of his obſervations and reaſonings on this ſubject, ſee *Memoires de l'Inſtitut Nation.* tom. iv. p. 269, 319. and 325.

SECT. II. *Of CARBONATED HYDROGEN GAS.*

412 Method of procuring.

1. If a quantity of wet charcoal be introduced into a retort, and expoſed to a red heat, a great quantity of gas paſſes over, which may be collected in jars in the pneumatic apparatus, in the uſual way. It may be alſo obtained by making the vapour of water paſs through red-hot charcoal in a porcelain or iron tube placed acroſs a furnace. The water is decompoſed; the hydrogen, one of its component parts, combines with the carbone of the charcoal. The gas obtained by theſe proceſſes has been called *light inflammable air*. A ſimilar gas may be procured from ether, ſpirits of wine or camphor, by making the vapour of theſe ſubſtances paſs through red-hot porcelain tubes. This gas, from its greater ſpecific gravity, has been called *heavy inflammable air*. The proportions of the ſubſtances which enter into the compoſition of this gas vary conſiderably, according to the proceſs employed, or the materials from which it is obtained. It is the ſame gas which is given out in great abundance during hot weather, from ſtagnant waters.

413 Properties.

2. This gas is like common air, inviſible and elaſtic. When a candle is applied to it, it burns with a blue, lambent flame. If it be mixed with atmoſpheric air, the combuſtion is more rapid and brilliant, and ſtill more ſo when it is mixed with oxygen gas, but without any detonation. The product of this combuſtion is carbonic acid and water. The oxygen combines partly with the carbone, and forms carbonic acid; and partly with the hydrogen, and forms water.

3. It is totally unfit for reſpiration. Animals introduced into it are inſtantly ſuffocated. It is alſo unfit for ſupporting combuſtion.

One of the moſt remarkable properties of this gas is, when it is mixed in a tube with common air or oxygen gas, about $\frac{2}{3}$ds its bulk of the latter, and fired by the electric ſpark, there is a conſiderable increaſe of volume.

414 Compoſition.

The component parts of carbonated hydrogen gas obtained from different ſubſtances, as they have been aſcertained by Mr Cruickſhank, are the following. When it is procured from ether, camphor, or ſtagnated water, it contains the greateſt proportion of carbone. The ſpecific gravity is 0.000804, and it is to common air nearly as two to three. One part by weight of hydrogen gas holds in ſolution $5\frac{1}{2}$ parts of carbone;

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[*] *Annal. de Chim.* tom. xxxix. p. 45.

[†] *Ibid.* p. 58.

100 parts contain 52.35 carbone,
9.60 hydrogen,
38.05 water inſtead of vapour.
100.00

When it is obtained from ether, the ſpecific gravity is 0.000787:

100 parts contain 45 carbone,
15 hydrogen,
40 water.
100

When it is obtained from ſpirit of wine, the ſpecific gravity is 0.00063:

100 parts contain 44.1 carbone,
11.8 hydrogen,
44.1 water.
100.0

The lighteſt is obtained from diſtilling wet charcoal, or paſſing the vapour of water through red-hot charcoal. It contains one part by weight of hydrogen gas, holding three parts of carbone in ſolution. The ſpecific gravity is 0.000554. It is to common air nearly as one to two;

100 parts contain 28 carbone,
9 hydrogen,
63 water.†
100

Mr Cruickſhank has diſcovered a very eaſy method of diſtinguiſhing the gaſeous oxide of carbone from the carbonated hydrogen gas. A mixture of the latter and oxymuriatic acid gas may be exploded by paſſing electric ſparks through it. But a mixture of oxymuriatic acid gas and the gaſeous oxide of carbone ſuffers no change by the action of electricity.

The following table, drawn up by Mr Cruickſhank, exhibits the reſults of his experiments on theſe two gaſes.

A Table, ſhewing the Analyſis, &c. of the different Species of Carbonated Hydrogen Gas, or Hydrocarbonates, and of the Gaſeous Oxide of Carbone.

Gaſes, and the different Subſtances from which the Gaſes are obtained, &c.	Weight of 100 Cubic Inches, or Grains.	Proportion of Oxygen neceſſary to ſaturate 100 Meaſures of the Gas.		Products when combined with Oxygen.				Hence the Gaſes conſiſt of			
				Carbonic Acid.		Water produced.	Water held in Solution by the Gas.				
	Grains.	Meaſ.	Quan. of Grains.	In Vol. Meaſ.	In Quan. Grains.	Grains.	Grains	Oxyg.	Carbon.	Hydrc.	Water.
Pure carbonated hydrogen gas from camphor, &c.	21	176	59,8	116	54,5	18	8 or 9	none	11	2+	8 or 9
—— from ether	20	170	58	108	50,5	18	9	none	9	3	8
—— from alcohol	16	118	40	75	36	13	7	none	7	1,9	7
—— wet charcoal	14,5	66	22,4	40	19	9	9	none	4	1,3	9
Gaſeous oxide from charcoal and metallic oxides	30	44	15	76	35,5	about 8	prob^y none	about 15	nearly 15	1+	uncertain
—— from iron filings, and carbonate of lime, or barytes	30	40	13,6	92	43,2	none	none	21+	8.6	none	none

Chap. VIII. Of PHOSPHORUS.

415 Hiſtory. 1. This ſingular ſubſtance was accidentally diſcovered in 1677 by an alchemiſt of Hamburg, named Brandt, when he was engaged in ſearching for the philoſopher's ſtone. Kunkel, another chemiſt, who had ſeen the new product, aſſociated himſelf with one of his friends named Krafft, to purchaſe the ſecret of its preparation; but the latter deceiving his friend, made the purchaſe for himſelf, and refuſed to communicate it. Kunkel, who at this time knew nothing farther of its preparation, than that it was obtained by certain proceſſes from urine, undertook the taſk, and ſucceeded. It is on this account that this ſubſtance long went under the name of Kunkel's phoſphorus. Mr Boyle is alſo conſidered as one of the diſcoverers of phoſphorus. He communicated the ſecret of the proceſs for preparing it to the Royal Society of London in 1680. It is aſſerted, indeed, by Krafft, that he diſcovered the ſecret to Mr Boyle, having in the year 1678 carried a ſmall piece of it to London, to ſhew it to the royal family; but there is little probability, that a man of ſuch integrity as Mr Boyle, would claim the diſcovery of the proceſs as his own, and communicate it to the Royal Society, if this had not been the caſe.

Mr Boyle communicated the proceſs to Godfrey Hankwitz, an apothecary of London, who for many years ſupplied Europe with phoſphorus; and hence it went under the name of *Engliſh phoſphorus*. Many chemiſts now attempted to produce phoſphorus, and different proceſſes had been publiſhed for the purpoſe; but it would appear that they rarely ſucceeded.

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† *Nicholſon's Journal*, vol. v. p. 1.

In the year 1737, a ſtranger having ſold to the French government a proceſs for making phoſphorus, the Academy of Sciences charged Dufay, Geoffroy, Duhamel, and Hellot, to ſuperintend it. The latter publiſhed an account of the experiment, which ſucceeded. Rouelle the elder exhibited phoſphorus which he had prepared, in the courſe which he opened at Paris ſome years after. In the year 1743, Margraaf made a great improvement in the proceſs, but ſtill it continued to be obtained with difficulty, and in very ſmall quantity. It was not till 30 years after that conſiderable improvement was made in the proceſs for procuring phoſphorus.

416 Exiſts in bones.

In the year 1774, the Swediſh chemiſts, Gahn and Scheele, made the important diſcovery, that phoſphorus is contained in the bones of animals, and they improved the proceſſes for procuring it.

417 Proceſs for obtaining

2. The moſt convenient proceſs for obtaining phoſphorus ſeems to be that recommended by Fourcroy and Vauquelin *. Take a quantity of burnt bones, and reduce them to powder. Put 100 parts of this powder into a porcelain or ſtone-ware baſon, and dilute it with four times its weight of water. Forty parts of ſulphuric acid are then to be added in ſmall portions, taking care to ſtir the mixture after the addition of every portion. A violent efferveſcence takes place, and a great quantity of air is diſengaged. Let the mixture remain for 24 hours, ſtirring it occaſionally, to expoſe every part of the powder to the action of the acid. The burnt bones conſiſt of the phoſphoric acid and lime; but the ſulphuric acid has a greater affinity for the lime than the phoſphoric acid. The action of the ſulphuric acid uniting with the lime, and the ſeparation of the phoſphoric acid, occaſion the efferveſcence. The ſulphuric acid and the lime combine together, being inſoluble, and fall to the bottom.

Pour the whole mixture on a cloth filter, ſo that the liquid part which is to be received in a porcelain veſſel may paſs through. A white powder, which is the inſoluble ſulphate of lime, remains on the filter. After this has been repeatedly waſhed with water, it may be thrown away, but the water is to be added to that part of the liquid which paſſed through the filter.

Take a ſolution of ſugar of lead in water, and pour it gradually into the liquid in the porcelain baſon. A white powder falls to the bottom, and the ſugar of lead muſt be added ſo long as any precipitation takes place. The whole is again to be poured upon a filter, and the white powder which remains is to be well waſhed and dried. The dried powder is then to be mixed with one-ſixth of its weight of charcoal powder. Put this mixture into an earthen-ware retort, and place it in a ſand bath with the beak plunged into a veſſel of water. Apply heat, and let it be gradually increaſed, till the retort becomes red hot. As the heat increaſes, air-bubbles ruſh in abundance through the beak of the retort, ſome of which are inflamed when they come in contact with the air at the ſurface of the water. A ſubſtance at laſt drops out ſimilar to melted wax, which congeals under the water. This is phoſphorus.

418 and purifying it.

In this ſtate the phoſphorus is not quite pure. It is generally mixed with ſome charcoal powder, and a portion of half burnt phoſphorus, which give it a brown colour. To have it quite pure, melt it in warm water, and ſtrain it ſeveral times through a piece of ſhamoy leather under the ſurface of the water (H). To mould it into ſticks, take a glaſs funnel with a long tube, which muſt be ſtopped with a cork. Fill it with water, and put the phoſphorus into it. Immerſe the funnel in boiling water, and when the phoſphorus is melted, and flows into the tube of the funnel, then plunge it into cold water, and when the phoſphorus has become ſolid, remove the cork, and puſh the phoſphorus from the mould with a piece of wood. Thus prepared, it muſt be preſerved in cloſe veſſels containing pure water.

419 Properties.

3. When phoſphorus is perfectly pure, it is ſemitranſparent, and has the conſiſtence of wax. It is ſo ſoft that it may be cut with a knife. Its ſpecific gravity is from 1.770 to 2.033. It has an acrid and diſagreeable taſte, and a peculiar ſmell ſomewhat reſembling garlic. When a ſtick of phoſphorus is broken, it exhibits ſome appearance of cryſtallization. The cryſtals are needle-ſhaped, or long octahedrons; but to obtain them in their moſt perfect ſtate, the ſurface of the phoſphorus, juſt when it becomes ſolid, ſhould be pierced, that the internal liquid phoſphorus may flow out, and leave a cavity for their formation.

420 Action of light.

4. When phoſphorus is expoſed to the light, it becomes of a reddiſh colour, which appears to be an incipient combuſtion. It is therefore neceſſary to preſerve it in a dark place. 421 Of heat. At the temperature of 99° it becomes liquid, and if air be entirely excluded, it evaporates at 219°, and boils at 554°. At the temperature of 43° or 44°, it gives out a white ſmoke, and is luminous in the dark. This is a ſlow combuſtion of the phoſphorus, which becomes more rapid as the temperature is raiſed. When phoſphorus is heated to the temperature of 148°, it takes fire, burns with a bright flame, and gives out a great quantity of white ſmoke.

Phoſphorus enters into combination with oxygen, azote, hydrogen, and carbone.

SECT. I. *Of the* COMBINATIONS *of* PHOSPHORUS *with* OXYGEN.

Phoſphorus enters into combinations with oxygen in different proportions.

I. Oxide of Phoſphorus.

When phoſphorus is expoſed to the light, or is kept in water that is not freed from air, it ſoon becomes of a white colour, having loſt its tranſparency, and afterwards

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* *Mem. de l'Inſt.* tom. ii. p. 282.

(H) The leather ſhould only be employed once, for the phoſphorus which is ſtrained through it afterwards will be coloured.

wards changes to a brown. This is the firſt combination of oxygen with it, and being in the ſmalleſt proportion, and giving no acid properties to the compound, it has been denominated an *oxide of phoſphorus*. This ſhews that it is neceſſary to keep it excluded from air and light. But phoſphorus thus changed on the ſurface may be freed from that part which is oxidated by a very ſimple proceſs. Diſſolve the phoſphorus in warm water, the whole melts except the oxidated part, which remains at the ſurface, becauſe it is not ſoluble at the ſame temperature.

422 To ſeparate the oxide.

II. Acids.

423 Production.

1. When phoſphorus is burned in common air confined in a veſſel, the combuſtion is pretty rapid, and continues till the whole of the oxygen be conſumed. A great quantity of white fumes are produced, and when theſe fumes are mixed with water which abſorbs them, it is found to have acid properties. This is the *phoſphorous acid*, in which the oxygen is in ſmaller proportion than in the following, but greater than in the oxide.

2. But when a ſmall bit of phoſphorus is introduced into a jar filled with oxygen gas at the temperature of 60°, it diſſolves ſlowly, but does not appear luminous till the temperature be raiſed to 80°, which ſhews that phoſphorus requires a higher temperature to burn in oxygen gas than in common air. And if the phoſphorus be introduced into the oxygen gas, which is perfectly pure at a lower temperature, it undergoes no change, gives out no ſmoke, and is not luminous in the dark. But when it is immerſed in a ſtate of ignition into oxygen gas, it exhibits the moſt brilliant combuſtion that can be conceived. The light which is emitted is almoſt as ſplendid as that of the ſun, and is too powerful for the eye. During this combuſtion the oxygen gas diſappears, it loſes its gaſeous form, and becomes ſolid in combination with the phoſphorus. It is during this change from the fluid to the ſolid ſtate that the caloric is emitted; and the light, according to Gren's theory of combuſtion, is given out by the phoſphorus. The product is a concrete ſubſtance which adheres to the ſides of the jar. This is the *phoſphoric acid*, in which there is a greater proportion of oxygen in combination with the phoſphorus. Theſe acids will be treated of in the chapter on acids.

424 Splendid combuſtion.

SECT. II. *Of PHOSPHORATED AZOTIC GAS.*

425 Phoſphorus combines with azotic gas without emitting light.

1. At firſt ſight it ſeems difficult to explain the reaſon that phoſphorus requires a higher temperature for its combuſtion in oxygen gas than in common air. But the cauſe of this ſingular phenomenon appears by examining the effects of azotic gas on phoſphorus. The phoſphorus, which is readily converted into vapour at a low temperature, combines with the azotic gas without combuſtion, and therefore without giving out any light. The azotic gas is thus ſaturated with the phoſphorus, and its bulk is increaſed about $\frac{1}{40}$. The combination is denominated *phoſphorated azotic gas*.

2. When oxygen gas is introduced into a jar filled with this gas, it becomes luminous, becauſe there is a combuſtion of the phoſphorus which is held in ſolution by the azotic gas. The combuſtion is more rapid and brilliant when the phoſphorated azotic gas is let up into the jar of oxygen gas.

SECT. III. *Of PHOSPHORIZED and PHOSPHORATED HYDROGEN GAS.*

426 Phoſphorus diſſolved in hydrogen gas.

1. When a piece of phoſphorus is put into a jar filled with hydrogen gas, it does not appear luminous in the dark. But, after having remained for ſeveral hours, part of the phoſphorus is diſſolved. When this gas, to which Fourcroy and Vauquelin have given the name of phoſphorized hydrogen gas, is introduced into a jar of oxygen gas, each bubble, as it paſſes up and comes in contact with the gas, produces a very brilliant bluiſh flame, which fills the whole veſſel. This effect does not take place in atmoſpheric air. This gas holds in ſolution only a ſmall proportion of phoſphorus; but it is owing to the combuſtion of this portion that the flame appears in the oxygen gas. This gas has a leſs fetid odour than that which is next to be deſcribed. It has, however, a ſlight ſmell of garlic *.

427 Hiſtory.

2. Phoſphorated hydrogen gas was diſcovered by M. Gengembre in 1783, by boiling a ſolution of potaſh on phoſphorus; and by Mr Kirwan in the following year. Its nature and properties have been more completely inveſtigated by M. Raymond, in two papers in the *Annales de Chimie* for 1791 and 1800. It may be obtained by introducing a bit of phoſphorus into a jar of hydrogen gas ſtanding over mercury, and melting the phoſphorus by means of a burning glaſs. The phoſphorus is thus converted into the ſtate of vapour, when the hydrogen gas diſſolves a much greater proportion. But a more ſimple proceſs has been recommended by Raymond.

428 Proceſſes for obtaining it.

Take two ounces of quicklime, ſlaked in the air, about 60 grs. of phoſphorus, and half an ounce of water; reduce the whole to a paſte, and put it immediately into a ſmall glaſs or ſtone-ware retort, the body of which may be filled with the materials. Immerſe the beak of the retort under water in the pneumatic trough, and apply a moderate heat. As ſoon as the retort is heated, the gas begins to come over; and when the bubbles come to the ſurface of the water in contact with the air, they explode with flame and ſmoke. When the gas paſſes off ſlowly the bubbles are larger; and when they reach the ſurface they exhibit an elegant appearance, forming, after exploſion, a beautiful coronet of white ſmoke, which riſes with an undulatory motion to the ceiling, when the air is ſtill. When this gas is brought into contact with oxygen gas, the combuſtion is more rapid and more brilliant.

429 Products by combuſtion.

The products of the combuſtion of this gas are phoſphoric acid and water. The phoſphorus which is held in ſolution by the hydrogen, combines with the oxygen, and forms phoſphoric acid; while the hydrogen unites with another portion of oxygen and forms water.

430 Properties.

This gas has a very fetid odour, which has ſome reſemblance to the ſmell of putrid fiſh. When pure water is agitated in contact with this gas, it abſorbs about one-fourth of its bulk at the temperature of 50°. The colour of the ſolution is not quite ſo deep as that of roll ſulphur. The ſmell is ſtrong and diſagreeable, and the taſte extremely bitter. It does not appear luminous in the dark. But when it is expoſed nearly to the temperature of boiling, the whole of the phoſphorated hydrogen gas is driven off unchanged, and the water remains behind perfectly pure. When the ſolution is expoſed to the air, the oxide of phoſphorus is depoſited, and the hydrogen gas eſcapes *.

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* *Ann. de Chim.* vol. xxi. p. 203.

Sect. IV. *Phosphuret of Carbone.*

430 How produced. Phoſphorus enters into combination with charcoal, and forms what Prouſt, who diſcovered it, denominates *phoſphuret of carbone*. It is produced during the diſtillation of phoſphorus, and remains behind on the leather, when it is ſtrained through it to purify it from this ſubſtance. It is of a red colour, and does not melt like pure phoſphorus. If it be diſtilled with a gentle heat, there is ſeparated a ſmall portion of phoſphorus which it contains in exceſs. But the true compound of phoſphuret of carbone is not decompoſed
431 Action of heat. without a very ſtrong heat. When the veſſels have cooled there is found a light, flocculent powder, of a lively orange red, which M. Prouſt conſiders as the phoſphuret of carbone. If it be expoſed to a red heat in the retort in which it is formed, the whole of the phoſphorus is driven off, and the charcoal remains behind. When this phoſphuret is expoſed to the open air on a heated metallic plate, it burns rapidly; but the charcoal which abſorbs the phoſphoric acid, as it is formed, eſcapes the combuſtion. It loſes, in a ſhort time, the property of burning, by being expoſed to the air, and then it may be preſerved without any riſk of its catching fire ſpontaneouſly †.

Chap. IX. Of SULPHUR.

432 A ſimple ſubſtance. 1. Sulphur is a ſimple undecompounded combuſtible ſubſtance, which is univerſally diffuſed in nature; but moſt commonly in a ſtate of combination with mineral, vegetable, or animal matters. It is found in ſome mineral waters, but in greateſt abundance in volcanic countries, where it is a valuable article of commerce.

433 Properties. 2. Sulphur, as it is extracted from minerals and purified by art, is a hard brittle ſubſtance of a yellow colour, which can be eaſily reduced to powder. It is always opaque, has a lamellated fracture, and becomes electric by friction. The ſpecific gravity, after it is melted, does not exceed 1.9907. It has no ſmell, and very little perceptible taſte. When it is rubbed ſome time, it is volatilized, and diffuſes a peculiar and ſlightly fetid odour, by which it is eaſily diſtinguiſhed. It leaves on the ſkin which has been in contact with it, a very ſtrong ſmell, which remains for ſome hours. It is inſoluble in water.

434 Action of heat. 3. Light has no ſenſible effect on ſulphur. But if a roll of ſulphur be held in the hand for a little, it begins to crackle, and at laſt it breaks to pieces. When a temperature equal to that of boiling water is applied to ſulphur, it melts, becomes liquid and tranſparent, and changes to a brown red colour; but, on cooling, if the fuſion is not too long continued, it reſumes the yellow
435 Cryſtallizes colour. If it be permitted to cool ſlowly, it cryſtallizes into priſmatic needles. The cryſtals are better formed by pouring out part of the liquid ſulphur as ſoon as the ſurface has become ſolid.

436 Becomes viſcid. 4. If the heat be continued it becomes thick and viſcid; and if it be then poured into cold water, it retains its ſoftneſs, ſo that it is employed for taking impreſſions of ſeals and medals. In this ſtate they are
437 Is ſublimed. called *ſulphurs*. When ſulphur is expoſed to heat in cloſe veſſels, it is volatilized or ſublimed in the form of a very fine powder, known under the name of FLOWERS OF SULPHUR.

Sulphur enters into combination with oxygen, azote, hydrogen, carbone, and phoſphorus.

438 With azotic gas. The combination of ſulphur with azotic gas has been little examined. Part of the ſulphur is diſſolved, when it is heated in a veſſel filled with the gas. This *ſulphurated azotic gas*, as it is called, has a fetid odour. When the temperature is diminiſhed, part of the ſulphur is depoſited. It has been lately diſcovered in the mineral waters of Aix-la-Chapelle.—We ſhall conſider the other combinations of ſulphur in the following ſections.

Sect. I. *Sulphur combined with Oxygen.*

439 Oxide. 1. When ſulphur is kept ſome time in fuſion in an open veſſel, it aſſumes a red colour, and becomes viſcid. After it is cooled, it retains its red colour, which is owing to the combination of oxygen in ſmall proportion with the ſulphur. In this ſtate it has been denominated the *oxide of ſulphur*. According to the experiments of Dr Thomſon, the oxide of ſulphur, formed by melting the ſubſtance in a deep veſſel, is of a dark violet colour, fibrous fracture, and tough conſiſtence; the ſpecific gravity is 2.325. It contained 2$\frac{4}{10}$ per cent. of oxygen. Another oxide, containing 6.2 per cent. of oxygen, was formed by paſſing a current of oxy-muriatic acid gas through flowers of ſulphur *.

440 Burnt in common air. 2. When ſulphur is burnt in the open air, it emits a pale blue flame, with a great quantity of white ſmoke. When theſe fumes are mixed with water, it is found to poſſeſs acid properties. This is a combination of ſulphur with a greater proportion of oxygen than exiſts in the oxide, and is called *ſulphurous acid*.

441 In oxygen gas. 3. But when ſulphur is burnt in oxygen gas, a very rapid combuſtion takes place with a reddiſh white flame, and it combines with a greater proportion of oxygen. When the fumes which are copiouſly emitted during this combuſtion are collected and mixed with water, it exhibits the properties of an acid, which is the *ſulphuric acid*. Thus it appears, that ſulphur combines with oxygen in four different proportions. In two of theſe, in which the proportions are ſmalleſt, the compounds are denominated oxides; but in the two others, in which the proportion of oxygen is increaſed, the compounds are acids, the properties of which will be afterwards inveſtigated.

Sect. II. *Sulphurated Hydrogen Gas.*

442 Method of procuring. 1. This gas may be procured by various proceſſes. It may be obtained by making hydrogen gas paſs through melted ſulphur. In this way the hydrogen gas enters into combination with ſulphur. The ſame gas may alſo be obtained by melting together in a crucible

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* *Ann de Chim.* vol. xxxv. p. 234.

† *Ibid* p. 44.

* *Syſt. of Chem.* vol. iv. p. 763.

equal parts of iron filings and ſulphur, by which means a black brittle maſs is formed, which is to be reduced to powder, and introduced into a glaſs veſſel (fig. 6.) with two mouths, the one of which has a ſtopper A and the other a bent tube B, accurately ground to fit the mouths C, D. When the mixture of iron filings and ſulphur has been introduced into the phial, the bent tube is to be fitted into the mouth, with the other end under the ſurface of the water in the trough E. The apparatus being thus prepared, pour in muriatic acid through the other opening, and immediately cloſe it with the ground ſtopper. The ſulphurated hydrogen gas is copiouſly diſengaged, and fills the glaſs jar F, which is previouſly placed on the ſhelf to receive it. This gas was formerly known by the name of *hepatic gas*.

443 Properties. 2. The odour is extremely fœtid, reſembling that from the waſhings of a gun, or from rotten eggs, which is owing to the extrication of the ſame gas. The ſpecific gravity of this gas is 0.00135.

It is unfit for reſpiration, and a taper immerſed in it is extinguiſhed, ſo that it is alſo unfit for ſupporting combuſtion. When it is inflamed in contact with atmoſpheric air or oxygen gas, it burns with a reddiſh blue flame, and depoſits a quantity of ſulphur. Sulphur alſo is depoſited by ſimple expoſure to the air. From this it appears, therefore, that the affinity of hydrogen for oxygen is ſtronger than for ſulphur. During the combuſtion, the hydrogen unites with the oxygen, and the ſulphur is depoſited. It is from this depoſition that the ſulphur found about mineral ſprings, the waters of which contain this gas, is derived.

444 Compoſition. 3. According to the experiments of Thenard, 100 parts by weight of ſulphurated hydrogen gas contain

70.857	ſulphur,
29.143	hydrogen.
100.000*.	

4. Sulphurated hydrogen gas has the property of diſſolving phoſphorus. Fourcroy and Vauquelin introduced pieces of phoſphorus into a jar filled with this gas over mercury. After the phoſphorus had been expoſed to the gas for twelve hours, the atmoſpheric air was admitted, and there inſtantly appeared a bluiſh, voluminous flame. 445 Diſſolves phoſphorus. The bubbles of the gas diffuſed in the air, preſented by day light a white vapour, which ſeemed to adhere like viſcid matter to the ſurface of the mercury; but in the dark, exhibited a very brilliant light. The mercury in the trough in which the experiment was made, continued for ſome minutes to give out ſparks of light by agitation. The hands plunged into this gas, continued luminous for ſome minutes, and a ſponge introduced into it retained the ſame property for ſome time in the air †.

5. Sulphurated hydrogen gas is very readily abſorbed by water, and in this ſtate it poſſeſſes ſome of the properties of an acid. It changes vegetable blues to a red colour.

Sect. III. *Carburet of Sulphur.*

446 With carbone in different proportions. 1. Sulphur and carbone combine together at a high temperature, and probably in different proportions; one of theſe combinations is liquid, at the ordinary temperature and preſſure of the atmoſphere. This is the carburet of ſulphur. The following method of preparing it is given by Clement and Deſormes, who have particularly inveſtigated the action of ſulphur and charcoal.

447 Preparation. 2. Put a quantity of charcoal in ſmall pieces, or in powder previouſly dried, into a porcelain tube, which is to paſs through a furnace that it may be expoſed to a red heat. The gas from the charcoal is to be allowed to eſcape, before the other part of the apparatus is adjuſted. To that extremity of the porcelain tube which contains the charcoal, fit a long glaſs tube, ſufficiently wide to contain a number of ſmall pieces of ſulphur, which may be puſhed ſucceſſively into the porcelain tube with an iron rod paſſing through a cock which cloſes the end of the tube. To the other extremity there is to be fitted another glaſs tube, bent at the end, that it may be immerſed in a veſſel of water in the pneumatic trough. Heat is then to be applied till the porcelain tube and the charcoal become red-hot, when the pieces of ſulphur are to be puſhed ſlowly forwards into the tube, and when it acts on the charcoal a yellow liquid of an oily appearance paſſes through the tube. The heat being continued, it evaporates, and is condenſed in the water of the veſſel in which the tube terminates, traverſing it in globules which collect together at the bottom.

448 Precautions. The ſucceſs of this experiment is ſomewhat doubtful. When ſulphur is expoſed ſuddenly to a ſtrong heat, in place of being ſublimed, it appears in ſome meaſure fixed, and becomes ſoft by fuſion. Sometimes it paſſes too rapidly through the charcoal to unite with it; the pieces of ſulphur, therefore, ſhould be ſlowly introduced, and the tube, in paſſing through the furnace, ſhould be inclined from that extremity at which the ſulphur is introduced.

449 Properties. 3. When the carburet of ſulphur is pure, it is tranſparent and colourleſs, but frequently has a greeniſh-yellow tinge. It has a diſagreeable pungent odour. The taſte is at firſt cooling, but afterwards becomes extremely pungent. It is heavier than water, does not mix with it, and therefore remains at the bottom of the veſſel. The ſpecific gravity of this liquor is various. In one trial it was found to be 1.3.

450 Evaporates. 4. The carburet of ſulphur evaporates at the ordinary temperature of the atmoſphere, and increaſes its volume nearly as much as ether. When a quantity of this liquor in a veſſel of water is placed under the receiver of an air pump, and the air exhauſted, it riſes through the water in bubbles, and aſſumes the gaſeous form; and when the preſſure of the air is reſtored, the gas is inſtantly condenſed, and returns to the liquid ſtate.

451 Combuſtible. 5. The carburet of ſulphur burns with great facility, and during the combuſtion it emits a ſtrong odour of ſulphurous acid, depoſites a little ſulphur, which afterwards burns, and there remains ſome black charcoal in its uſual combuſtible ſtate. The air which holds carburet of ſulphur in ſolution, burns quietly; but when it is mixed with oxygen gas, and brought in contact with a burning body, it explodes with prodigious violence, and not without conſiderable danger.

6. This ſubſtance unites with phoſphorus, which it very readily diſſolves, but the ſolution is not more inflammable than the phoſphorus itſelf. It combines

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* *Ann de Chim.* vol. xxxii. p. 267.

† *Ibid.* vol. xxi. p. 207.

alſo with a ſmall quantity of ſulphur, but without any other change in its properties than becoming a little deeper coloured. It ſeems to have no action on charcoal *.

* Ann. de Chim. vol. xii. p. 134.

Sect. IV. *Sulphuret of Phosphorus.*

452 Preparations. 1. Sulphur and phoſphorus combine together in all proportions. If one part of phoſphorus with eight times its weight of ſulphur, be put into a matraſs, with 32 parts of diſtilled water; on the application of a gentle heat, the phoſphorus melts and diſſolves the ſulphur. The new compound aſſumes a yellow colour, and remains fluid, till it is cooled down to the temperature of 77°, when it becomes ſolid. This ſubſtance is the *ſulphuret of phoſphorus*. In other caſes, when the proportion of phoſphorus exceeds that of the ſulphur, it is called a *phoſphuret of ſulphur*.

453 Combined with ſulphur more fuſible. 2. The compounds of ſulphur and phoſphorus have been particularly inveſtigated by Pelletier, and he has found that the compound is always more fuſible than either of the uncombined conſtituents. The following table exhibits the reſults of his experiments †.

† Fourcroy Connaiſs. Chim. tom. i. p. 202.

8 Phoſphorus 1 Sulphur	remain fluid at 95°
4 Phoſphorus 1 Sulphur	59
1 Phoſphorus ½ Sulphur	50
1 Phoſphorus 1 Sulphur	41
1 Phoſphorus 2 Sulphur	72
1 Phoſphorus 3 Sulphur	99

All theſe compounds, therefore, it muſt appear, are more fuſible than the phoſphorus itſelf, and much more ſo than the ſulphur.

454 Danger in the proceſs. 3. In making theſe combinations, great caution ſhould be obſerved; for if the heat be applied ſuddenly, even when the ſubſtances are under water, a violent exploſion ſometimes takes place, from the ſudden formation and extrication of the ſulphurated and phoſphorated hydrogen gaſes.

Chap. X. Of ACIDS.

455 Oxides. 1. We have ſeen, in deſcribing the different ſubſtances which have been treated of in the five preceding chapters, that they all, excepting one, combine with oxygen in different proportions. Hydrogen combines with oxygen only in one proportion, and this compound is water. The firſt portion of oxygen which combines with the other four ſubſtances, namely azote, carbone, phoſphorus, and ſulphur, forms with them compounds which, poſſeſſing no acid properties, have received the name of oxides (I).

456 Acids. 2. But when theſe ſubſtances combine with a greater proportion of oxygen, they exhibit very different properties; and poſſeſſed of theſe properties, they are ranked among the claſs of acids. The ſubſtances which poſſeſs the following properties are referred to this claſs.

457 Diſtinctive characters. *a*. They redden vegetable blue colours (K).

b. They poſſeſs a peculiar taſte, which is well known by the terms *acid* or *ſour*.

c. They combine with water in all proportions.

d. They enter into chemical combination with alkalies, with earths, and metallic oxides, and form with them compounds which have been denominated *ſalts*.

458 Importance of acids. 3. The acids are a very important claſs of bodies, and not merely on account of their peculiar properties, and the ſingular and uſeful compounds which they form with other ſubſtances, but alſo as they are the inſtruments of analyſis in the hands of the chemiſt for diſcovering the properties and combinations of the objects of his ſcience. Without their aid he can ſcarcely move a ſingle ſtep in his inveſtigations. It was therefore neceſſary to introduce the account of the acids in this place, that we might be early acquainted with the means of proſecuting our reſearches.

459 Nomenclature. 4. Acids which have the ſame baſe, combine with oxygen in different proportions. Thus, for inſtance, ſulphur combines with oxygen in two proportions. The 100 parts of one compound contain 32 of oxygen, and the 100 parts of the other contain 38 parts. The characteriſtic properties of theſe compounds are totally different. It is therefore neceſſary that they ſhould be diſtinguiſhed by ſome appropriate name, and this accordingly has been attended to in the conſtruction of the preſent chemical nomenclature. The name of the acid is derived from the baſe, and this name has a different termination according to the proportion of the oxygen combined with its baſe. With the ſmalleſt proportion the name terminates in the ſyllable *ous*; with the greater proportion, it terminates in the ſyllable *ic*. Thus, in the caſe of the acid formed with ſulphur, that compound in which there is the ſmaller proportion of oxygen is denominated the *ſulphurous acid*; the other, which has the greater proportion of oxygen is the *ſulphuric acid*. In the ſame way when phoſphorus combines with oxygen in the ſmalleſt proportion which gives it acid properties, it is called the *phoſphorous acid*; in the greater proportion, the *phoſphoric acid*. And thus by the ſimple change of the termination, the name is deſcriptive of the peculiar ſtate of the proportions in the compound.

(I) Perhaps the combination of oxygen and azote, as they exiſt in atmoſpheric air, ſhould be excepted. It is to the combination of oxygen in greater proportion with azote than exiſts in atmoſpheric air, that the name of oxide is given. But philoſophers are not agreed whether atmoſpheric air is to be conſidered as a chemical combination, or a mechanical mixture.

(K) Hence vegetable blue infuſions, or paper ſtained with them, are employed as teſts to diſcover acids. Theſe are ſometimes called re-agents. A great variety of ſubſtances are employed for this purpoſe, ſuch as the infuſion and tincture of litmus and of turnſole, the ſyrup of violets, the infuſion of the flowers of mallow or red cabbage,

Sect. I. *Of Sulphuric Acid.*

460 Names. 1. The name of ſulphuric acid is given to the combination of ſulphur and of oxygen, with the greateſt proportion of the latter. It was formerly called vitriolic acid, becauſe it was obtained by diſtillation from vitriol, which is a compound of ſulphuric acid and an oxide of iron. When it is ſtrongly concentrated, it has a ſluggiſh appearance; hence it was called *oil of vitriol*. It has alſo been denominated *oleum ſulphuris per campanam*, becauſe it was obtained by burning ſulphur under a glaſs bell.

461 Hiſtory. 2. The ancients were unacquainted with this acid. Pliny ſpeaks of vitriols, which were uſed for different purpoſes, in ſome of which it was probably decompoſed. Sulphur was burnt in ſacrifices, but in neither caſe was the product attended to. Baſil Valentine is the firſt who mentions this acid, about the end of the 15th century. Agricola and Paracelſus have alſo ſpoken of it, but Dornæus is the firſt who deſcribed it diſtinctly, in the year 1570.

462 Formation by experiments. 3. If a quantity of flowers of ſulphur be expoſed to a degree of heat ſufficient to inflame it, and if, when it is in a ſtate of ignition, it be introduced into a jar filled with oxygen gas, it burns with great ſplendor, and emits a great quantity of white fumes. Theſe fumes may be condenſed, by pouring a ſmall quantity of water into the jar, and when this is examined, it is found to poſſeſs acid properties. This is the *ſulphuric acid*. It is procured, as appears by this experiment, by burning ſulphur in oxygen gas.

463 And in the large way. 4. The proceſs for obtaining ſulphuric acid in the large way is the following. A mixture of ſulphur and nitre is burnt in leaden chambers. The uſe of the nitre is to ſupply a quantity of oxygen for the combuſtion of the ſulphur. There is a little water in the bottom of the veſſels, which ſerves to condenſe the vapours given out during the combuſtion. The acid which is obtained in this way is very weak, for it is diluted with the water in which it was condenſed, which water may be ſeparated by diſtillation. Even after this it is uſually contaminated with a little lead from the veſſels, ſome potaſh, and ſometimes nitric and ſulphurous acids. 464 Purification. To obtain it perfectly pure, the ſulphuric acid of commerce muſt be diſtilled. This proceſs is conducted by putting a quantity of the acid into a retort, and expoſing it to a degree of heat ſufficient to make it boil. The beak of the retort is put into a receiver, in which the acid, as it comes over, is condenſed.

465 Properties. 5. The acid thus purified, is a tranſparent colourleſs liquid, of an oily conſiſtence. It has no ſmell, but a ſtrong acid taſte. It deſtroys all animal and vegetable ſubſtances. It reddens all vegetable blues. It always contains water. When this is driven off by a moderate heat, the acid is ſaid to be concentrated. When as much concentrated as poſſible, the ſpecific gravity is 2, or double that of water; but it can rarely be obtained of greater denſity than 1.84.

466 Action of heat. 6. Sulphuric acid ſuffers no change from being expoſed to the light. It boils at the temperature of 546°, or, according to Bergman, 540°. When this acid is deprived of its caloric, it is ſuſceptible of congelation, and even of cryſtallization, in flat, ſix-ſided priſms, terminating in a ſix-ſided pyramid. It cryſtallizes moſt readily, when it is neither too much concentrated, nor diluted with water. Of the ſpecific gravity of 1.65 it cryſtallizes at the temperature of a few degrees below the freezing point of water. Of the ſpecific gravity of 1.84 it reſiſts the greateſt degree of cold. Chaptal obſerved it cryſtallize at the temperature of 48°, and Mr Keir found that it froze at 45° of the ſpecific gravity of 1.78.

467 Attracts water ſtrongly. 7. Sulphuric acid has a ſtrong attraction for water. In ſome experiments that have been made, ſulphuric acid, when expoſed to the atmoſphere, attracted above ſix times its weight of water. When four parts of concentrated ſulphuric acid, and one part of ice at the temperature of 32°, are mixed together, the moment they come in contact the ice melts, and the temperature riſes to 212°. A greater quantity of caloric is given out when the two bodies are mixed together in the liquid ſtate. If four parts of the acid and one of water are ſuddenly mixed together, the temperature of the mixture riſes to about 300°. This extrication of caloric, it is obvious, ariſes from the ſudden condenſation of the two liquids, the medium bulk of which is conſiderably leſs than the two taken together.

468 Method of determining the quantity. 8. So great is the attraction of this acid for water, that the ſtrongeſt that can be prepared can ſcarcely be ſuppoſed to be entirely free from it. It has therefore greatly occupied the attention of chemical philoſophers to determine the proportions of real acid and water, in ſulphuric acid of any given ſpecific gravity. This ſubject has been inveſtigated by Wenzel, Wiegleb, and Bergman, and more lately and ſucceſsfully by Mr Kirwan. 469 Mr Kirwan's. His method was the following. Eighty-ſix grains of potaſh, diſſolved in water, were ſaturated with ſulphuric acid of a known ſpecific gravity. The ſolution being turbid, water was added till the ſpecific gravity was 1.03 at temperature 60°. The whole weight was now equal to 3694 grains. Forty-five grs. of ſulphate of potaſh diſſolved in 1017 grs. of diſtilled water, had the ſame ſpecific gravity at the temperature 60°. Hence the proportion of ſalt in each ſolution was equal. But in the laſt, the quantity of ſalt was $\frac{1}{22.6}$, then the quantity of ſalt in the former was $\frac{3694}{22.6} =$ 163.45 grains. Of this quantity only 86 were alkali; the remainder, therefore, viz. 77.45 grains, were acid, or acid and water. The quantity of acid employed in the ſaturation amounted to 79 grs. ſtandard; but the quantity of acid taken up was only 77.45 grs. therefore 1.55 were rejected, and conſequently were mere water, therefore the acid taken up is ſtronger than ſtandard; and ſince 79 parts ſtandard loſe 1.55 by combining with pure potaſh, 100 parts ſtandard ſhould loſe 1.96; or 98.04 parts of acid of the ſtrength of what is found in ſulphate of potaſh, contains as much real acid as 100 parts ſtandard. Hence 100 parts of this ſtrong acid are nearly equivalent to 102 of ſtandard. Therefore, 100 parts of potaſh take up nearly 92 of ſtandard ſulphuric acid, or 82 of the ſtrongeſt, and afford 182 of ſulphate of potaſh. Mr Kirwan thinks there is no reaſon to ſuppoſe that the ſulphate of

potaſh contains any water of cryſtallization. One hundred grs. expoſed to a red heat for half an hour fell into powder, and loſt only a ſingle grain *.

It having been ſuggeſted by Guyton-Morveau, Mr Kirwan obſerves, that the denſities of mixtures of ſulphuric acid and water being greater than what is found by calculation, ſhould be aſcribed to the condenſation of the aqueous part, rather than to that of the acid; this led him to conſider of a different method from what he had formerly employed in determining the quantity of real acid in ſulphuric acid of different denſities. Sulphuric acid of the ſpecific gravity of 2.000, which is the ſtrongeſt that can be produced by art, was taken as the ſtandard of the ſtrength of all other acids. He could not procure the acid of this ſtrength at the temperature of 60°. But from many experiments made with acids of inferior denſity, as 1.8846, 1.8689, 18042, 1.7500, he concludes, that the condenſation of equal weights of this ſtandard acid and water amounts to $\frac{1}{73}$th of the whole. Then by applying Mr Pouget's formula (1.) for inveſtigating the increaſed denſities of inferior proportions of acid and water, the ſucceſſive increments of denſity will be found as in the following table.

Parts.

* Iriſh Tranſ. vol. iv. p. 18.

(1.) The formula here alluded to was invented by M. Pouget in the inveſtigation of the ſpecific gravity of alcohol mixed with water in different proportions; and he has given a detailed account of his method in a letter addreſſed to Mr Kirwan, which is inſerted in the Tranſactions of the Royal Iriſh Academy, vol. iii. p. 157.

Having purified alcohol by repeated diſtillations, the ſpecific gravity at the temperature 65.75° was found to be 0.8199. This he took for his ſtandard. And conſidering the ſpecific gravity as the means of diſcovering the increaſe of denſity, or the diminution of volume, he thought the quantities in the mixture would be beſt determined, not by the difference of weight, but of volume. He therefore took ten mixtures, the firſt containing nine meaſures of alcohol and one of water, the ſecond eight meaſures of alcohol and two of water, and ſo on to the laſt, which contained only one meaſure of alcohol and nine of water. But as the real meaſures are always uncertain, he weighed them to aſcertain the ſpecific gravity. Thus 10,000 grains of water and 8199 of alcohol formed a mixture of equal parts in bulk. Knowing the real ſpecific gravities of mixtures of alcohol and water, taking a mean of a great number of obſervations made at the ſame temperature, and comparing them with the ſpecific gravities found directly by calculation, he thus deduces the increaſe of denſity or the diminution of volume produced in the whole maſs by the mutual penetration of the fluids. For calling A the real ſpecific gravity, and B the ſpecific gravity found by calculation, n the number of meaſures which compoſe the whole maſs, $n-x$ that to which it is reduced by mutual penetration, it is evident, ſince this increaſe of denſity does not diminiſh the weight of the whole maſs, that $n\,B = \overline{n-x} \times A$. Then $x = \frac{A-B}{A} \times n$, or making $n = 1\,\frac{A-B}{A}$, which expreſſes the diminutions of bulk, or the quantities of fluid abſorbed during the mixture.

The following table contains the reſult of Pouget's experiments, or the diminutions of volume which is ſuppoſed to be $= 1$ of each of the mixtures, calculated according to the formula.

Number of meaſures of		Diminution of the whole volume = 1 by experiment.	By calculation.
Water.	Alcohol.		
1	9	0.0109	0.0103
2	8	0.0187	0.0184
3	7	0.0242	0.0242
4	6	0.0268	0.0276
5	5	0.0288	
6	4	0.026	0.0276
7	3	0.0207	0.0242
8	2	0.0123	0.0184
9	1	0.0044	0.0103

From this table it appears that the numbers which expreſs the diminution of bulk follow a regular progreſſion. The greateſt correſpond to the mixtures of equal parts, and they decreaſe towards each end of the progreſſion. They muſt therefore be regulated by ſome general law. M. Pouget thinks that the alcohol may

Parts Water.	Standard.	Increments of Denſity.
5	95	,0252
10	90	,0479
15	85	,0679
20	80	,0856
25	75	,0699
30	70	,1119
35	65	,1213
40	60	,1279
45	55	,1319
50	50	,1333

“ By adding, ſays Mr Kirwan, theſe increments to the ſpecific gravities found by calculation, and taking arithmetical mediums for the intermediate quantities of ſtandard, I made out the firſt 50 numbers of the following table; the remainder was formed by actual obſervation in the following manner, premiſing that the ſpecific gravities were always taken between 59,5° and 60°, or at moſt 60,5° of Fahrenheit.

“ 1ſt, I found by the preceding part of the table that 100 parts of ſulphuric acid whoſe ſpecific gravity was 1.8472 contained 88,5 parts ſtandard; conſequently 400 grs. of this acid contain 354.

“ 2dly, I then took ſix portions of this acid, each containing 400 grs. and added to them as much water as made them contain reſpectively 48. 46. 44. 42. 40. and 38. grains ſtandard. To find the proportion of water that

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may be conceived as being diſſolved in the water which has abſorbed or retained part of it in its pores. The quantity abſorbed ought to be in the ratio of that of the ſolvent and the body diſſolved, and each meaſure of water will retain quantities of alcohol proportional to the number of meaſures of this fluid in the mixture. Thus for example, in a mixture formed of nine meaſures of alcohol and one of water, this meaſure of water will abſorb a quantity of alcohol $=9$: and in another mixture of eight meaſures of alcohol with two of water, each meaſure of water will contain a quantity of alcohol $=8$. Conſequently the diminutions of bulk of each mixture are in a ratio compounded of the number of meaſures of alcohol and of water which form it; and in the table above, as 1×9, 2×8, 3×7, 4×6, 5×5, &c. And in general taking for a conſtant quantity the diminution of bulk with equal meaſures, and calling it c; calling the whole number of meaſures n; the number of meaſures of alcohol in any mixture, x, and the increaſe of denſity or diminution of volume z, we ſhall have $c:n::\frac{n}{2}\times\frac{n}{2}:\overline{n-x}\times x$: and $z=\frac{4c}{n2}\times\overline{nx-x^2}$: or making $n=1$, $4cx-4cx^2$. The increaſe of denſity, calculated according to the formula, correſponds pretty nearly with experiments; for all mixtures in which the alcohol is in greater quantity than water, but not in thoſe caſes in which the water is in greateſt proportion, the real increaſe of denſity is much leſs than by calculation, and the differences become more conſiderable as the quantity of water is increaſed. M. Pouget thinks, that when the quantity of water is greater than that of alcohol, the law of abſorption is diſturbed; and he conjectures that it is owing to the attraction of the particles of the water among themſelves, which conſequently oppoſe their union with any other ſubſtance. But when the alcohol forms at leaſt the half of the whole maſs, the diminutions of bulk are as the products of the numbers which expreſs the proportions of alcohol and water forming the mixture: they may be repreſented by the formula $z=\frac{4cnx-4cx^2}{n^2}$. By this formula may be determined the ſtrength of ſpirits of wine of commerce, or the number of parts of water and ſtandard alcohol of which they are compoſed.

The number of meaſures of the whole maſs or the bulk - $=1$
The number of meaſures of alcohol in any mixture - - $=x$;
The diminution of bulk of equal parts by experiment - - $=c$
The diminution of bulk of a mixture containing x meaſures of alcohol by hypotheſis $=4cx-4cx^2$
The ſpecific gravity of water - - - $=a$
Specific gravity of alcohol - - - - $=b$
Specific gravity of the unknown mixture - - $=y$

Since the increaſe of denſity does not change the weight of the maſs, we ſhall have $\overline{1-x}\times a+bx=\overline{1-4cx+4cx^2}\times y$.

By this equation may be found the value of x or the proportion of alcohol, having previouſly aſcertained the ſpecific gravity of the mixture, and to determine this ſpecific gravity, or the value of y, by knowing the proportions of alcohol and water. Hence

$$x=0.5-\frac{a-b}{8cy}+\sqrt[2]{\frac{a-y}{4cy}+\left(\frac{a-b}{8cy}-0.5\right)}^{2}$$

$$y=\frac{a-ax+bx}{1-4cx+4cx^2}$$

And making $a=1$, $b=0.8199$, $c=0.0288$

$$x=0.5\frac{0.1801}{0.2304y}+\sqrt[2]{\frac{1-y}{0.1152y}+\left(\frac{0.1801}{0.2304y}-0.5\right)}$$

$$y=\frac{1-0.1801x}{1-0.1152x+0.1152x^2}$$

that ſhould be added to each portion of acid, in order that it ſhould contain the given proportion of ſtandard, I uſed the following analogy: Let the quantity of water to be added to 400 parts of the acid that the mixture may contain 48 per cent. ſtandard be x.

Then $400+x. 354 :: 100. 48$, then $19200+48x. =35400$.

And $48x=35400-19200=16200$. And $x=\frac{16200}{48} =337,5$.

" In this manner I found the quantities of water to be added to each of the other portions. The mixtures being made, they were ſet by for four days, ſtirring them with a glaſs rod (that remained in them) each day, and the 5th day they were tried; after which the half of each was taken out and as much water added to them, and then ſet by for three days, by which means the ſpecific gravities correſponding to 24. 23. 22. 21. 20. and 19. per cent. ſtandard were found, after which ſix more portions of 400 grs. each of the concentrated acid, whoſe ſpecific gravity was 1,8393, were taken, the proper proportion of water added to each, and after three days reſt and repeated agitation, their denſities in temperature 60° were examined as above, by which means the ſpecific gravities correſponding to 36. 34. 32. 30. 28. and 26. per cent. ſtandard were obtained, and half theſe portions mixed with half water exhibited, after three days reſt and agitation, the denſities correſponding to 18. 17. 16. 15. 14. and 13. per cent. ſtandard in the above temperature. The balance I uſed turned with $\frac{1}{12}$ of a grain when charged with two ounces, and the ſolid employed was a ſmall glaſs ball containing mercury which loſt 27,88 grs. of its weight when weighed in water in temperature 56°, ſuſpended commonly by a horſe-hair, but when dipped in ſtrong nitrous and marine acids it is ſuſpended by a fine gold wire, and then loſt 27,78 grs. of its weight in water.

" I alſo examined and rectified, in ſome inſtances, many parts of the firſt 50 numbers of the table in the ſame manner, but in general I found them juſt.

TABLE of the Quantity of the Standard Sulphuric Acid 2,000 in Sulphuric Acid of inferior Denſity.

100 Parts.	Standard Temp. 60°	100 Parts.	Standard.	100 Parts.	Standard.
2,000	100	1,7959	84	1,6312	68
1,9859	99	1,7849	83	1,6217	67
1,9719	98	1,7738	82	1,6122	66
1,9579	97	1,7629	81	1,6027	65
1,9439	96	1,7519	80	1,5932	64
1,9299	95	1,7416	79	1,5840	63
1,9168	94	1,7312	78	1,5748	62
1,9041	93	1,7208	77	1,5656	61
1,8914	92	1,7104	76	1,5564	60
1,8787	91	1,7000	75	1,5473	59
1,8660	90	1,6899	74	1,5385	58
1,8542	89	1,6800	73	1,5292	57
1,8424	88	1,6701	72	1,5202	56
1,8306	87	1,6602	71	1,5112	55
1,8188	86	1,6503	70	1,5022	54
1,8070	85	1,6407	69	1,4933	53

TABLE Continued.

100 Parts.	Standard Temp. 60°.	100 Parts.	Standard	100 Parts.	Standard
1,4844	52	1,2951	35	1,1398	18
1,4755	51	1,2847	34	1,1309	17
1,4666	50	1,2757	33	1,1208	16
1,4427	49	1,2668	32	1,1129	15
1,4189	48	1,2589	31	1,1011	14
1,4099	47	1,2510	30	1,0955	13
1,4010	46	1,2415	29	1,0896	12
1,3875	45	1,2320	28	1,0833	11
1,3741	44	1,2210	27	1,0780	10
1,3663	43	1,2101	26	1,0725	9
1,3586	42	1,2009	25	1,0666	8
1,3473	41	1,1918	24	1,0610	7
1,3360	40	1,1836	23	1,0555	6
1,3254	39	1,1746	22	1,0492	5
1,3149	38	1,1678	21	1,0450	4
1,3102	37	1,1614	20	1,0396	3
1,3056	36	1,1531	19	1,0343	2

" The laſt eleven numbers were only found by analogy, obſerving the ſeries of decrements in the four preceding denſities, and therefore are to be conſidered barely as approximations.

" To reduce vitriolic acids of given denſities, at any degree of temperature between 49° and 70°, to that which they ſhould have at temperature 60°, in order that their proportion of ſtandard may be thereby inveſtigated, I made the following experiments.

Degrees of Temperature.	Sp. Gr. of A.	Sp. Gr. of B.	Sp. Gr of C.
70°	1,8292	1,6969	1,3845
65	1,8317	1,6983	1,3866
60	1,8360	1,7005	1,3888
55	1,8382	1,7037	1,3898
50	1,8403	1,7062	- -
49	1,8403	- -	1,3926

" Hence we ſee that vitriolic acid, whoſe denſity at any degree between 49° and 70° reſembles or approaches the correſponding denſity in the column A, gains or loſes 0,00126 of its ſpecific gravity by *every two* degrees between 60° and 70° of Fahrenheit, and 0,00086 by *every two* degrees between 49° and 60°.

" Secondly, That any vitriolic acid, whoſe denſity at any degree between 50° and 70° reſembles or approaches to the correſponding denſity in the column B, gains or loſes 0,00158 for every two degrees between 60° and 70°; and 0.0017 by every two degrees between 50° and 60°. Whence it appears that the ſtronger acid is leſs altered by variation of temperature than the weaker, which formerly appeared to me an irregularity, but now ſeems to proceed from the increaſe of the accrued denſity, when larger proportions of water are mixed with the ſtronger acid.

" 3dly, Sulphuric acid, whoſe denſity at any degree between 50° and 70° reſembles the correſponding at the ſame degree in the column C, gains or loſes 0.00086 for every two degrees between 60° and 70° incluſively, and 0.00076 between 50° and 60°. Between 45° and 50° I could perceive no difference *.

470 Compoſition. 9. Attempts have been made to determine the proportion of oxygen and ſulphur, which enter into the compoſition of ſulphuric acid. According to the experiments of Lavoiſier, in which he meaſured the quantity of oxygen abſorbed, by a given weight of ſulphur during combuſtion, the proportions are,

71 ſulphur,
29 oxygen.
100

But other methods have been adopted, which promiſe more accurate reſults. Theſe are, by decompoſing other ſubſtances which contain oxygen, by means of ſulphur. According to the experiments of Mr Chenevix, conducted in this way, the ſulphuric acid conſiſts of

61.5 ſulphur,
38.5 oxygen.
100.0

10. Sulphuric acid does not combine with oxygen, nor has it any action with azotic gas.

471 Action with hydrogen. 11. It appears that hydrogen has a greater affinity for oxygen, than the ſulphur has, and therefore the ſulphuric acid is decompoſed by means of hydrogen gas. In the cold there is no action between hydrogen gas and ſulphuric acid; but if they are made to paſs through a red-hot porcelain tube, the acid is decompoſed; water is formed, and ſulphur is precipitated. When hydrogen gas is employed in a greater proportion than the half of the acid, the ſuperabundant gas diſſolves the ſulphur, and is diſengaged in the form of ſulphurated hydrogen gas.

472 Charcoal. 12. Charcoal has no action on ſulphuric acid in the cold; but at the boiling temperature, it decompoſes it, and converts it into ſulphurous acid. If a piece of red-hot charcoal be immerſed in a quantity of concentrated ſulphuric acid, part of the acid is ſuddenly diſengaged under the form of thick white fumes, accompanied with ſulphurous acid gas. The ſulphuric acid is decompoſed; part of its oxygen is attracted by the charcoal, forming carbonic acid, and thus it is reduced to the loweſt proportion of oxygen, in the ſtate of ſulphurous acid.

473 Phoſphorus. 13. A ſimilar effect is produced by phoſphorus. Phoſphorus, with the aſſiſtance of heat, partially decompoſes the ſulphuric acid, by abſtracting part of its oxygen. Phoſphoric acid is formed, and ſulphurous acid driven off.

474 Sulphur. 14. In the cold, ſulphur has no action on ſulphuric acid; but, when they are boiled together, the ſulphur is partly diſſolved in the acid, and converts it into ſulphurous acid. The ſulphur which has been added combines with the oxygen, which is neceſſary for the conſtitution of ſulphuric acid, and thus the whole is converted into ſulphurous acid.

475 Sulphates. 15. Sulphuric acid combines with alkalies, the earths and the metals forming ſalts; which, in the preſent language of chemiſtry, are denominated *ſulphates*.

476 Uſes. 16. This acid is employed in great quantity in many arts and manufactures. It is employed alſo in medicine and pharmacy; the preparation of it, therefore, has long been an object of conſiderable importance.

477 Affinities. 17. The affinities of ſulphuric acid are the following:

Barytes,
Strontites,
Potaſh,
Soda,
Lime,
Magneſia,
Ammonia,
Glucina,
Yttria,
Alumina,
Zirconia,
Oxide of Zinc,
Iron,
Manganeſe,
Cobalt,
Nickel,
Lead,
Tin,
Copper,
Biſmuth,
Antimony,
Arſenic
Mercury,
Silver,
Gold,
Platina.

SECT. II. *Of SULPHUROUS ACID.*

478 Names. 1. According to the explanation of the nomenclature of the acids, the term *ſulphurous* ſhows that this acid is in its diminiſhed ſtate of combination with oxygen. It was formerly called *ſpirit of ſulphur*, and *volatile ſulphurous acid.*

479 History. Although the ancients muſt have been acquainted with ſome of its properties, as it is formed during the ſlow combuſtion of ſulphur, yet Stahl is the firſt chemiſt who examined it with attention. He ſuppoſed that it was the ſulphuric acid combined with his imaginary principle of phlogiſton. Hence he called it *phlogiſticated* ſulphuric acid. It was not till the year 1774 that its nature and compoſition were diſcovered by the labours of Prieſtley and Lavoiſier. Berthollet afterwards inveſtigated the formation, decompoſition, combinations, and uſes of this acid. Fourcroy and Vauquelin * alſo have examined many of its properties, eſpecially the ſaline compounds which it forms, ſo that now its properties are well known.

480 Abundant in nature. 2. The ſulphurous acid exiſts in nature in great abundance, and particularly in the neighbourhood of volcanoes. It is diſengaged from ſome lavas in a ſtate of fuſion, and from the ſoil which is impregnated with ſulphur, when a ſufficient degree of heat is applied.

481 Fatal to Pliny. It was by the vapours of ſulphurous acid that Pliny the naturaliſt was ſuffocated in the eruption of Mount Veſuvius, which deſtroyed Herculaneum, in the 79th year before the Chriſtian æra.

482 Formation. 3. When ſulphur is burnt in the open air, the fumes that are generated by this ſlow combuſtion, are ſulphurous acid. It was in this way that this acid was for-

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* *Iriſh Tranſ.* vol. iv. p 7.

* *Ann. de Chim.* tom. xxiv. p. 229.

merly obtained. The method of procuring it, which is now followed, is to decompoſe the ſulphuric acid by means of any ſubſtance which deprives it of part of its oxygen. If one part of mercury and two parts of concentrated ſulphuric acid be expoſed to heat in a glaſs retort, the mixture effervesces, and a gas is diſengaged, which may be collected in jars over mercury. In this proceſs the mercury attracts part of the oxygen of the ſulphuric acid, and leaves behind that portion which conſtitutes the ſulphurous acid.

483 In the ſtate of gas. 4. Sulphurous acid thus obtained is in the ſtate of gas, and it is an elaſtic, inviſible and colourleſs fluid, like common air. It is rather more than double the weight of atmoſpheric air.

484 Properties. Its ſpecific gravity is 0.00246; 100 cubic inches weigh nearly 63 grains. It has a ſharp pungent ſmell; it is unfit for reſpiration, and for ſupporting combuſtion. It reddens vegetable blues, and then deſtroys the greater number of them. It is on account of this property that the fumes of ſulphur are employed to remove the ſtains of fruit from linen, and that the ſulphurous acid is often uſed in bleaching.

485 Action with caloric. 5. Sulphurous acid gas refracts the light ſtrongly without undergoing any change. When it is ſtrongly heated, as in a red-hot porcelain tube, it remains unaltered, according to the experiments of Fourcroy. But Dr Prieſtley and Berthollet found that it depoſited ſulphur, after long expoſure to heat. At the temperature of —31° it becomes liquid. This property, which diſtinguiſhes it from other gaſes, and which was diſcovered by Monge and Clouet, Fourcroy thinks is owing to the water it holds in ſolution.

486 With oxygen gas, &c. 6. When ſulphurous acid is in the form of gas, it does not readily combine with oxygen. In its fluid form it unites more freely, and is converted into ſulphuric acid. In making a mixture of ſulphurous acid gas and oxygen gas paſs through a red-hot tube, they combine together, and are converted into ſulphuric acid. There ſeems to be no action between ſulphurous acid and azotic gas.

487 With hydrogen gas. 7. Hydrogen gas has no action on ſulphurous acid gas in the cold; but when a mixture of theſe gaſes is made to paſs through a red-hot tube, ſulphurous acid is decompoſed; the hydrogen combines with the oxygen and forms water, and ſulphur is depoſited. If the hydrogen gas be in greater proportion than the oxygen contained in the ſulphurous acid, it diſſolves part of the ſulphur, and paſſes off in the form of ſulphurated hydrogen gas.

488 With charcoal. 8. Its action with charcoal is ſomewhat ſimilar. In the cold there is no effect; but expoſed together to a red heat, carbonic acid is formed, by the union of carbone and oxygen, and ſulphur is depoſited.

489 With phoſphorated hydrogen gas. 9. There is no action whatever between phoſphorus and ſulphurous acid gas; but phoſphorated hydrogen gas is decompoſed by this acid. When the two gaſes come in contact, a white thick vapour is produced; ſulphur combined with phoſphorus in the ſolid ſtate is depoſited, and water is formed.

490 Sulphurated hydrogen gas. 10. Sulphur has no action on this acid; but ſulphurated hydrogen gas, at the inſtant it comes in contact with ſulphurous acid gas, is condenſed; ſolid ſulphur is depoſited, and water is formed, with the extrication of caloric by the condenſation of the two gaſes.

491 With water. 11. Water has a ſtrong attraction for ſulphurous acid gas. A bit of ice brought in contact with it, is immediately melted without any perceptible change of temperature. When water is ſaturated with this gas, it is known by the name of *ſulphurous acid*, or *liquid ſulphurous acid*. The ſpecific gravity is 1.040. At the temperature of 43° water combines with $\frac{1}{3}$ of its weight of ſulphurous acid gas†; but as the temperature increaſes, it abſorbs it in ſmaller proportion. It freezes at a temperature a few degrees below 32°, and it paſſes into the ſolid ſtate without parting with any of its acid. Liquid ſulphurous acid has the ſmell, taſte, and other properties of the gas, and particularly that of deſtroying vegetable colours. When expoſed to the atmoſphere, it gradually abſorbs oxygen, and paſſes into the ſtate of ſulphuric acid. This change goes on more rapidly when it it diluted with water, and agitated in contact with the air.

492 With ſulphuric acid. 12. Sulphuric acid ſeparates the ſulphurous acid in the gaſeous form from its combinations, and even from water. Concentrated ſulphuric acid abſorbs this gas, which imparts to it a yellowiſh brown colour, and renders it pungent and fuming. The two acids ſtrongly attract each other, ſo that when they are expoſed to the action of heat, the firſt vapour which riſes cryſtallizes in long, white, needle-ſhaped priſms.

493 Glacial ſulphuric acid. This is a compound of the two acids. It ſmokes in the air; diſſolves with efferveſcence in it, and when thrown into water produces a hiſſing noiſe, like a red-hot iron. It has the ſtrong ſmell of ſulphurous acid. This ſubſtance was formerly called *glacial ſulphuric acid**.

494 Uſes. 13. Sulphurous acid is very much employed in the arts, and ſometimes in medicine. In the ſtate of gas it is uſed for the bleaching of ſilk and wool, by extracting the colouring matter. It removes alſo the ſtains ariſing from vegetable juices, and ſpots of iron from linen.

495 Compoſition. 14. According to Fourcroy, 100 parts of this acid are compoſed of

85 ſulphur,
15 oxygen.
100

But according to the analyſis of Dr Thomſon,

68 ſulphur,
32 oxygen.
100

15. The compound ſalts formed by this acid are denominated *ſulphites*.

496 Affinities. 16. The following are the affinities of this acid.

Barytes,
Lime,
Potaſh,
Soda,
Strontites,
Magneſia,
Ammonia,
Glucina,
Alumina,
Zirconia.

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† *Fourcroy, Connaiſſ. Chim.* ii. 76.

* *Ibid.* ii. p. 78.

SECT. III. *Of Nitric Acid.*

497 Names. 498 Hiſtory. 1. This acid was formerly known by the name of aqua fortis, and ſpirit of nitre. Raymond Lully, who lived in the 13th century, ſeems to have been acquainted with it; and Baſil Valentine, who lived in the 15th, deſcribes the proceſs for preparing it. He calls it *water of nitre.* But till the diſcoveries of modern chemiſtry, little was known of the nature, properties, and compoſition of this acid. It is to the experiments and reſearches of Cavendiſh and Prieſtley, of Lavoiſier and Berthollet, that we are indebted for the knowledge we poſſeſs of this acid.

499 Abundant in nature. 2. Nitric acid exiſts in great abundance in nature. It is formed by the union of its conſtituent parts, which are evolved during the putrefactive proceſs of animal and vegetable matters; but it is never found, except in combination with ſome baſe, from which it muſt be extracted by art. The component parts of nitric acid, are azote and oxygen. The name in this caſe is not derived from the baſe, which is azote, but from nitre, from which it is generally obtained. This acid cannot be formed merely by bringing in contact the two gaſes which are its conſtituent parts; but if they are mixed together in certain proportions, and electric ſparks ſent through the mixture, the gaſes diſappear, and are converted into a liquid. This is *nitric acid.* By a ſimilar experiment Mr Cavendiſh diſcovered the compoſition of this acid.

500 Method of procuring it. 3. This acid may be obtained by putting three parts of nitre or ſaltpetre with one of ſulphuric acid into a glaſs retort, and diſtilling with a ſtrong heat. The gas which comes over is condenſed in a glaſs receiver, to which the retort is to be luted. The gas which is condenſed is nitric acid. Nitre is compoſed of nitric acid and potaſh: but potaſh has a ſtronger affinity for ſulphuric acid than for nitric acid; it therefore combines with the ſulphuric acid in the retort, and the nitric acid is diſengaged, and paſſes over in the gaſeous form.

501 Of purifying. 4. The acid thus obtained is impure, and is contaminated with muriatic, and ſometimes with ſulphurous acid. It is purified by diſtillation with a gentle heat. At firſt too it is of a yellow colour, which is owing to the fumes of nitrous gas with which it is combined. Theſe fumes are driven off by heat, after which the acid remains pure, and is tranſparent and colourleſs.

502 Properties. 5. Thus prepared, it has a ſtrong acid taſte; a diſagreeable pungent odour, and gives a yellow colour to the ſkin. The ſpecific gravity of ſtrong nitric acid is 1.583, or, according to Mr Kirwan, at temperature 60°, 1.554.

503 Diſcovery of its compoſition. 6. Nitric acid and one of its compounds, nitre, have long been the ſubject of the experiments and reſearches of chemical philoſophers. In inveſtigating the nature of nitre, Mayow found that it poſſeſſed a common property with atmoſpheric air; namely, the property of giving a red colour to the blood. And, from obſerving that air was deprived of this property by the proceſs of combuſtion and reſpiration, he drew the ſingular concluſion, that nitre contained that part of the air which is neceſſary for reſpiration and combuſtion.

7. When nitric acid diſſolves metallic ſubſtances, a great quantity of a peculiar gas makes its eſcape, and the metal acquires conſiderable weight during this proceſs. According to the phlogiſtic theory, it was ſuppoſed that the metal was deprived of its phlogiſton, and that this phlogiſton had combined with the nitrous gas which had eſcaped. This was Dr Prieſtley's explanation. But it was differently explained by Lavoiſier. He took 1104 grs. of mercury, and added to it 945 grs. of nitric acid. Nitrous gas was emitted during the ſolution, and when he expoſed the mercury which had been converted into an oxide, to a red heat, oxygen gas was given out, and the mercury appeared in the metallic ſtate. He therefore concluded, that the nitric acid in this caſe was decompoſed, and that it conſiſted of oxygen which combined with the metal, and of nitrous gas which was driven off. The proportions, he ſuppoſed, were, 64 parts of nitrous gas by weight, and 36 of oxygen gas. He found, however, that the quantity of oxygen obtained in this proceſs, was ſometimes greater than what was neceſſary to ſaturate the nitrous gas; and he was at a loſs to account for this quantity. His own experiments, as well as ſome of Dr Prieſtley's, proved, that azote is a component part of nitre.

Mr Cavendiſh, who diſcovered the compoſition of water, in his experiments and reſearches on that ſubject, found, that nitric acid was produced during the exploſion of oxygen and hydrogen gaſes; and that he could increaſe this quantity by adding azotic gas to the mixture before combuſtion. From this he concluded, that the formation of the acid depended on the azotic gas. He proved this by paſſing electrical ſparks through common air in a glaſs tube. The air diminiſhed in bulk, and nitric acid was formed. Repeating a ſimilar experiment with oxygen and azotic gaſes in certain proportions, he found that the whole could be converted into nitric acid *. Mr Cavendiſh repeated the ſame experiments, with a view to remove ſome objections which had been made to his concluſions. They were followed by the ſame reſult, ſo that the fact of the compoſition of nitric acid was fully eſtabliſhed †.

To perform this experiment, take a glaſs tube of about one-ſixth of an inch in diameter. Cloſe one end with a cork, through which let a metallic conductor with a ball at each extremity be paſſed. Fill the tube with mercury; immerſe the open end into the mercurial trough; introduce a mixture of .13 parts of azotic gas, and .87 of oxygen gas, occupying three inches of the tube, and a ſolution of potaſh filling one-half inch more. Let electrical exploſions be ſent through the tube till the air ceaſes to be diminiſhed in bulk. If the experiment ſucceed, the potaſh will be found converted into nitre, which ſhews that the nitric acid, which is a component part of nitre, has been formed during the proceſs.

504 Abſorbs water. 8. Nitric acid, having a ſtrong affinity for water, is never found entirely deprived of this liquid. When expoſed to the air, it attracts moiſture from it, and heat is given out when it is mixed with water. Mr Kirwan has endeavoured to aſcertain the relative 505 Method of determining the quantity. ſtrength of nitric acid of different denſities, or ſpecific gravities; and the method which he adopted is the following. He ſaturated 36 grs. of carbonate of ſoda

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* *Phil. Tranſ.* 1784.

† *Ibid.* 1788, p. 261.

with 147 grs. of nitric acid, of ſpecific gravity 1.2754, which contained 45.7 per cent. of ſtandard acid of ſpecific gravity 1.5543. The carbonic acid which eſcaped amounted to 14 grs.; and by adding 939 grs. of water, the ſpecific gravity of the ſolution, at the temperature of 58.5°, was 1.0401. By a ſimilar teſt with that employed in aſcertaining the ſtrength of ſulphuric acid, namely, by comparing this ſolution with one of nitrate of ſoda of the ſame denſity, he found the quantity of ſalt amounted to $1.\frac{16}{901}$ parts. There was an exceſs of acid of about 2 grs. The whole weight was 1439 grains. The quantity of ſalt, therefore, was $\frac{1439}{16.901} = 85.142$ grs. The quantity of pure alkali was $.50 - 14 = 36.05$ grs. The quantity of ſtandard acid was 66.7; the ſum of both = 102.75. Of this quantity only 85.142 entered into combination with the ſalt; the remaining 17.608 were mere water, given out by the ſtandard acid. If then 66.7 parts ſtandard acid loſe 17.608 parts water combining with the alkali, 100 parts ſhould loſe 26.38. And, as Mr Kirwan has made it probable, that nitrate of ſoda contains very little water in its compoſition; 100 parts of ſtandard nitric acid is compoſed of 73.62 of pure acid, and 26.38 of water ‡.

‡ Iriſh Tranſ. vol. iv. p. 34.

The following table drawn up by Mr Kirwan ſhews the quantity of pure acid in nitric acid of different ſpecific gravities.

100 Parts. Sp. Gravity.	Real Acid.	100 Parts. Sp. Gravity.	Real Acid.
1.5543	73.54	1.4171	53.68
1.5295	69.86	1.4120	52.94
1,5183	69.12	1.4069	52.21
1.5070	68 39	1.4018	51.47
1.4957	67.65	1.3975	50.74
1.4844	66.92	1.3925	50.00
1.4731	66.18	1.3875	49.27
1.4719	65.45	1.3825	48.53
1.4707	64.71	1.3775	47.80
1.4695	63.98+	1.3721	47.06
1.4683	63.24	1.3671	46.33
1.4671	62.51	1.3621	45.59
1.4640	61.77	1.3571	44.86+
1.4611	61.03	1.3521	44.12
1.4582	60.30	1.3468	43.38
1.4553	59.56	1.3417	42.65
1.4524	58.83	1.3364	41.91
1.4471	58.09	1.3315	41.18
1.4422	57.36	1.3264	40.44
1.4373	56.62	1.3212	39.71
1.4324	55.89	1.3160	38.97
1.4275	55.15	1.3108	38.34
1.4222	54.12+	1.3056	37.50
1.3004	36.77	1.2015	25.00
1.2911	36.03	1.1963	24.26
1.2812	35.30+	1.1911	23.53
1.2795	34.56	1.1845	22.79
1.2779	33.82	1.1779	22.06
1.2687	33.09	1.1704	21.32
1.2586	32.35	1.1639	20.59
1.2500	31.62	1.1581	19.85
1.2464	30.88	1.1524	19.12
1.2419	30.15	1.1421	18.48
1.2374	29.41	1.1319	17.65+
1.2291	29.68	1.1284	16.91
1.2209	27.94	1.1241	16.17
1.2180	27.21+	1.1165	15.44
1.2152	26.47	1.1111	14.70
1.2033	25.74+	2.1040	13.27

From experiments made by Mr Davy, he has deduced the real quantities of nitric acid in ſolutions of different ſpecific gravities, and by his eſtimation the proportions will appear in the following table *.

* Davy's Reſearches. p. 41.

Table of the quantities of True Nitric Acid in ſolutions of different Specific Gravities.

100 Parts Nitric Acid of ſpecific gravity	True Acid (M).	Water.
1,5040	91,55	8,45
1,4475	80,39	19,61
1,4285	71,65	28,35
1,3906	62,96	37,04
1,3551	56,88	43,12
1,3186	52,03	47,97
1,3042	49,04	50,96
1,2831	46,03	53,97
1,2090	45,07	54,73

506 Action of light.

9. When colourleſs nitric acid is expoſed to the light, it undergoes a partial decompoſition. Some oxygen gas is ſeparated, the acid aſſumes an orange yellow colour, and part of it paſſes into the ſtate of nitrous acid.

10. It boils at the temperature of 248°, and is entirely diſſipated without alteration, if the heat be continued. When it is made to paſs through a red-hot porcelain tube, it is decompoſed, and converted into its conſtituent parts, oxygen and azotic gaſes †. When nitric

† Fourcroy Connaiſ. Chim. tom ii. p. 81.

(M) The quantities of oxygen and nitrogen in any ſolution, may be thus found: Let A = the true acid, X the oxygen, and Y the nitrogen,

$$\text{Then } X = \frac{238\,A}{239} \text{ and } Y = \frac{A}{239}.$$

nitric acid (N) is cooled down to the temperature of —55°, it begins to cryſtallize in a few minutes, aſſumes a deep-red colour, and congeals into a thick maſs reſembling butter, by agitating the veſſel which contains it [*].

507 Of oxygen. 11. There is no action between nitric acid and oxygen or azotic gaſes; but when concentrated nitric acid is expoſed to the air, the vapour which it exhales combines with the moiſture of the atmoſphere, forms white fumes, and is condenſed into a liquid.

508 Hydrogen. 12. Hydrogen gas has no action on nitric acid at the ordinary temperature of the atmoſphere; but if they are made to paſs through a red-hot porcelain tube, there is a violent combuſtion with detonation. Water is formed by the combination of the hydrogen with the oxygen of the acid; and azotic gas, its other conſtituent part, is evolved.

509 Charcoal. 13. Nitric acid is alſo decompoſed by charcoal at a high temperature. Carbone combines with the oxygen and forms carbonic acid, while the azotic gas is ſet at liberty.

510 Phoſphorus and ſulphur. 14. It is alſo decompoſed in the ſame way by phoſphorus and ſulphur. When the acid is poured upon theſe combuſtibles at a high temperature, inflammation takes place, and they are converted into phoſphoric and ſulphuric acids.

511 Of ſulphuric acid. 15. When nitric and ſulphuric acids are mixed together, heat is evolved. The ſulphuric acid attracts the water which exiſted in the nitric acids, and this water being more condenſed in combination with ſulphuric acid, the caloric with which it was combined along with the nitric acid, is given out. Thus, the nitric acid becomes more concentrated by the addition of the ſulphuric acid.

512 Of ſulphurous acid. When nitric and ſulphurous acids are mixed together, a very different action takes place. The nitric acid ſeparates it from water and its other combinations; parts with its oxygen, and thus converts it into ſulphuric acid, and paſſes itſelf into the ſtate of nitrous gas.

513 Compoſition. 16. According to Lavoiſier, the proportions of the component parts of nitric acid are, one part azote and four parts oxygen. This was the reſult of his experiments on the decompoſition of nitre by charcoal. According to Mr Cavendiſh, the proportions of the azote and oxygen combined by electricity are one part azote and 2.346 of oxygen. The reſult of Mr Davy's experiments ſhews that 100 parts of pure nitric acid are compoſed of

29.5 azore,
70.5 oxygen.
———
100.0

514 Combination. 17. The combinations which are formed with the nitric acid, and the alkalies, earths, and oxides of metals, are denominated *nitrates*.

515 Affinities. 18. The order of the affinities of nitric acid is the following:

Barytes,
Potaſh,
Soda,
Strontites,
Lime,
Magneſia,
Ammonia,
Glucina,
Alumina,
Zirconia,
Oxide of Zinc,
Iron,
Mangeneſe,
Cobalt,
Nickel,
Lead,
Tin,
Copper,
Biſmuth,
Antimony,
Arſenic,
Mercury,
Silver,
Gold,
Platina.

516 Uſes. 19. This is one of the moſt important of the acids, conſidered as an inſtrument of analyſis in the hands of the chemiſt. It is employed in many arts. It is alſo uſed in medicine, in diſeaſes of the ſkin; and it has lately been exhibited as a cure in venereal affections. In this caſe, perhaps, it may be regarded as a uſeful auxiliary to the ordinary remedies.

Sect. IV. *Of Nitrous Acid.*

517 Method of procuring. 1. According to the preſent nomenclature nitrous acid ſhould bear the ſame relation to nitric acid that ſulphurous acid bears to ſulphuric; that is, the conſtituent parts of nitric acid ſhould be in different proportion from thoſe of nitrous acid; but this does not appear to be the caſe. What is uſually denominated nitrous acid, may be formed by combining nitrous gas with nitric acid: Or if the lower ſtratum in a veſſel of nitric acid be ſlowly decompoſed by a metallic ſubſtance, the oxygen of the acid combines with the metal; nitrous gas is evolved, which combines with the ſuperior ſtrata of the nitric acid, and converts it into nitrous acid [†]. It has then aſſumed a yellow colour, and its ſpecific gravity is diminiſhed. The ſame effect takes place when nitric acid is expoſed to light. It is deprived of part of its oxygen, and nitrous gas is evolved, which mixes with the acid, changes it to a yellow colour, and converts it into nitrous acid.

518 Compoſition. 2. Thus it appears that nitrous acid is nitric acid combined with nitrous gas. The acid of commerce, or what is commonly called *aqua fortis*, is nitrous acid.

519 Combines in different proportions with nitrous gas. 3. Nitric acid combines in different proportions with nitrous

[*] *Annal. de Chim.* tom. xxix. p. 282.

[†] *Fourcroy Connaiſſ. Chim.* tom. ii. p. 93.

(N) The acid employed in this experiment contained nitrous gas.

nitrous gas, which gives riſe to many varieties of nitrous acid; and, according to the quantity of nitrous gas abſorbed, the acid exhibits very different colours. The following table, drawn up by Mr Davy, ſhews in one view the proportions of nitric acid and nitrous gas, in different coloured nitrous acids.

Table containing Approximations to the quantities of Nitric Acid, Nitrous Gas, and Water in Nitrous Acids, of different colours and ſpecific gravities.

100 Parts.		Specific gra		Nitric Acid.	Water.	Nitrous Gas.
Sol. nitric acid	of	1,504	contain	91,55	8,45	———
Yellow nitrous ‡		1,502		90,5	8,3	1,2
Bright yellow		1,500		88,94	8,10	2,96
Dark orange		1,480		86,84	7,6	5,56
Light olive ‡		1,479		86,00	7,55	6,45
Dark olive ‡		1,478		85,4	7,5	7,1
Bright green ‡		1,476		84,8	7,44	7,76
Blue green *		1,475		84,6	7,4	8,00

520 Action of light and heat.

4. Light has no action on nitrous acid; but when heat is applied, the nitrous gas is driven off, and the nitric acid remains behind. In the ſtate of vapour, nitrous acid remains unchanged by the action of heat.

5. Neither oxygen gas, azotic gas, nor atmoſpheric air, produce any change on nitrous acid.

521 Combuſtibles.

6. On combuſtible bodies the action of nitrous acid is nearly ſimilar to that of the nitric acid; but many ſubſtances are more rapidly inflamed by nitrous acid. This ſeems not only to depend on the ſtate of the diviſion or rarefaction of the nitrous gas combined with the nitric acid, but alſo on the nitrous gas itſelf being more eaſily decompoſed, and giving up its oxygen, which is leſs ſtrongly attracted by the azote, on account of the great proportion of caloric united with it in the gaſeous ſtate. It decompoſes phoſphurated and ſulphurated hydrogen gas, and precipitates the phoſphorus and the ſulphur.

522 Sulphuric acid.

7. Sulphuric acid combines with the vapour of nitrous acid, which communicates the property of diſpoſing the ſulphuric acid to cryſtallize. Nitrous acid converts ſulphurous into ſulphuric acid, and, at the ſame time, parts with its nitrous gas.

523 Compounds.

8. Nitrous acid enters into combination with the alkalies and earths. The compounds are diſtinguiſhed by the name of *nitrites*. Theſe compounds are not made by direct combination, and therefore the affinities of this acid are little known.

Sect. V. *Of Muriatic Acid.*

524 Compoſition unknown.

1. The component parts of this acid are unknown. No attempt which has hitherto been made to diſcover its conſtituent parts, has yet ſucceeded. But, as it reſembles the other acids, the compoſition of which has been diſcovered, in many of its properties and combinations, it is uſually arranged among this claſs of bodies. The name of muriatic acid is derived from the Latin word *muria*, which ſignifies ſea-ſalt, or common ſalt, from which the acid is uſually extracted. It was formerly denominated *ſpirit of ſalt*, *acid of ſalt*, and *marine acid.*

525 Names.

526 Method of procuring.

2. Muriatic acid may be obtained by putting 100 parts of dry common ſalt, and 35 parts of ſulphuric acid, into a retort or matraſs with a bent tube. The beak of the retort at the end of the tube muſt communicate with a receiver in which there is water, that the muriatic acid may be condenſed as it paſſes into the receiver. In this way liquid muriatic acid may be obtained.

527 In the ſtate of gas.

3. But if the gas which comes over is received in a jar inverted in the mercurial apparatus, its properties may be examined in the ſtate of gas. When it firſt paſſes over, it is in the form of white ſmoke.

528 Properties.

4. Muriatic acid gas poſſeſſes the phyſical properties of common air. It is an inviſible elaſtic fluid. It has a ſtrong acid taſte, and a very pungent ſmell. The ſpecific gravity, according to Kirwan, is 0.002315.

5. It is unfit for reſpiration, and equally ſo for ſupporting combuſtion.

529 Action of water.

6. This gas has a ſtrong attraction for water. If a little water be introduced into a jar filled with this gas, ſtanding over mercury, the whole of the gas will be abſorbed, and the mercury will inſtantaneouſly riſe to the top. Or if a jar filled with muriatic acid gas be inverted into a veſſel of water, coloured with vegetable blue, the water ſuddenly ruſhes into the jar, which it completely fills, and the blue colour is changed to red, exhibiting the uſual effects of acids on vegetable colours.

530 Light and heat.

7. Light has no action whatever on this gas, nor does it undergo any change when it is made to paſs through a red-hot porcelain tube. In the ſtate of gas, it has no action upon oxygen gas. When this gas comes in contact with atmoſpheric air, thick white fumes are produced, with the extrication of caloric. This is a combination of the gas with the water in the atmoſphere, by which they are mutually condenſed.

8. There is no action between muriatic acid gas and azote, hydrogen, charcoal, phoſphorus, or ſulphur.

531 Combines with water in great proportion.

9. The quantity of water which muriatic acid abſorbs is very conſiderable. Ten grs. of water combine with ten grs. of the gas. The liquid acid thus formed occupies the ſpace of 13.3 grs. and hence its ſpecific gravity is 1.500; and the ſpecific gravity of the pureſt muriatic acid in its condenſed ſtate is 3.300 (o).

The ſpecific gravity of the ſtrongeſt muriatic acid that can eaſily be procured and preſerved, is 1.196.

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* "The blue green acid is not homogeneal in its compoſition: it is compoſed of the blue green ſpherules and the bright green acid. The blue green ſpherules are of greater ſpecific gravity than the dark green acid, probably becauſe they contain little or no water.

‡ "The compoſition of the acids thus marked, is given from calculations."

(o) "Let D = the denſity of a mixture; *m* the weight of the denſer ingredient; *d* its denſity; *l* the weight of

One hundred parts of this, Mr Kirwan calculates, will contain about 49 of acid, whoſe ſpecific gravity is 1.500, which he calls the ſtandard acid. By mixing this acid with different proportions of water, he obtained the reſults from which he conſtructed the following table.

Table of the quantity of Real Acid in 100 *parts of Muriatic Acid of different Specific Gravities, at the Temperature* 60°.

100 Parts. Sp. Gravity.	Real Acid.	100 Parts. Sp. Gravity.	Real Acid.
1.196	25.28	1.1282	16.51
1.191	24.76	1.1244	15.99
1.187	24.25	1.1206	15.48
1.183	23.73	1.1168	14.96
1.179	23.22	1.1120	14.44
1.175	22.70	1.1078	13.93
1.171	22.18	1.1036	13.41
1.167	21.67	1.0984	12.90
1.163	21.15	1.0942	12.38
1.159	20.64	1.0910	11.86
1.155	20.12	1.0868	11.35
1.151	19.60	1.0826	10.83
1.147	19.09	1.0784	10.32
1.1414	18.57	1.0742	9.80
1.1396	18.06	1.0630	8.25
1.1358	17.54	1.0345	5.16
1.1320	17.02	1.0169	2.58

532 Properties.

10. Liquid muriatic acid, in its ordinary ſtate, is of a pale yellow colour; but when it is pure, it is tranſparent and colourleſs.

533 Action of light and heat.

11. Light has no action whatever on muriatic acid. When heat is applied, it readily aſſumes the gaſeous form. Neither oxygen nor azotic gaſes are abſorbed by muriatic acid, nor has this acid any action on hydrogen, charcoal, phoſphorus, or ſulphur.

534 Of ſulphuric acid.

12. Sulphuric acid ſeparates the muriatic acid from its compounds, and even from its combination with water; but the muriatic acid drives off the ſulphurous acid from this liquid.

535 Of nitric acid.

13. One of the moſt remarkable characters of muriatic acid, is its combination with nitric acid. When theſe two acids are mixed together, they act upon each other, are ſtrongly heated, and produce effervеſcence, with a change of colour to an orange red. A mixed acid is thus formed, which poſſeſſes properties which exiſted neither in the one acid nor the other when in a ſtate of ſeparation. It was formerly called *aqua regia*, from its property of diſſolving gold, which was diſtinguiſhed by the name of *king of the metals*. It is now denominated *nitro-muriatic acid*. This acid is not to be conſidered as a ſimple mixture of the two acids. A double attraction takes place in their mutual action; the muriatic acid attracts part of the oxygen of the nitric acid, and the nitric combines with the nitrous gas. The muriatic acid thus combined with a portion of oxygen, is diſengaged with effervеſcence in yellow fumes: the undecompoſed nitric acid ſeizes the nitrous gas which is formed, and when it is ſaturated with it, the action ceaſes. Hence ariſes the colour of the mixed acid. The peculiar effect of the nitro-muriatic acid on metallic ſubſtances, will be deſcribed in treating of the metals.

536 Nitro-muriatic acid.

537 Suppoſed formation of muriatic acid.

14. In analyſing a mineral water, Mr Lambe concluded, from ſome appearances which preſented themſelves during his experiments, that the muriatic acid was formed or generated; for when iron was acted upon by ſulphurated hydrogen gas, oxymuriate of iron was formed. He digeſted iron filings, previouſly purified, in a ſolution of ſulphurated hydrogen gas, in diſtilled water. A bottle was filled with the ſolution, and corked. The iron was preſently acted upon; air was extricated, probably hydrogen gas, which drove the cork out of the bottle. The liquor, gradually loſt its odour, and at the end of ſome days it had a ſmell reſembling that of ſtagnant rain water. As the bubbles ceaſed to be produced, it recovered its tranſparency: A ſmall quantity of this ſolution evaporated to dryneſs, left behind a bitter, deliqueſcent ſalt. Sulphuric acid dropt on this ſalt, and paper moiſtened with ammonia, held over the glaſs, produced vapours, ſo that ſome volatile acid was ſeparated. Eight ounce meaſures of the ſame liquor were evaporated, and a little ſulphuric acid was dropt on the reſiduum. A ſtrong effervеſcence was excited, and acid fumes aroſe, which, from their ſmell, were readily known to be muriatic acid. Paper moiſtened with water rendered the vapours viſible in the form of a gray ſmoke, which is the diſtinguiſhing characteriſtic of muriatic acid. The ſame appearances were exhibited with the ſame reſult, when manganeſe and mercury were diſſolved in ſulphurated hydrogen gas *.

The ſame experiments have been repeated; but no traces of muriatic acid, in any of the compounds that were formed, could be found. In an experiment by Berthollet, indeed, iron filings waſhed with water which gave no marks of containing muriatic acid, when they were expoſed ſome days to the air, and again waſhed, exhibited ſome traces of it; ſo that the acid itſelf, or its elements, muſt have come from the air or the iron.

15. The

* *Manch. Mem.* vol. x. p. 194.

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of an equal bulk of water; and m', d', and l the ſame elements of the rarer: Then $D=\frac{m+m'}{l+l'}$. In the above caſe, $m+m'=20$, and $l+l'=13.3$. Then $D=\frac{20}{13.3}=1.5$. Now to find the ſpecific gravity of the condenſed muriatic acid gas, we have from the above equation $l=\frac{m+m'-l'D}{D}=\frac{5}{1.5}=3.3$; and $d=\frac{m}{l}=\frac{10}{3.3}=3.03$. *Kirwan. Iriſh Tranſactions*, vol. iv. p. 5.

538 Action of electricity. 15. The bulk of muriatic acid gas is greatly diminiſhed by the action of electricity, and hydrogen gas is given out; but this action is limited. Mr Henry has ſhewn that it is not owing to the decompoſition of the acid, as might at firſt ſight be ſuppoſed, but to the decompoſition of water which it holds in ſolution; ſo that the action continues as long as there is any moiſture in the gas. The oxygen of the water combines with the acid, and forms oxymuriatic acid; while the hydrogen of the water is evolved.

539 Uſes in deſtroying noxious vapours. 16. Muriatic acid gas has been ſucceſsfully employed in deſtroying noxious, putrid exhalations. It was applied in this way in the year 1773 by Morveau, in purifying the cathedral of Dijon from theſe exhalations, on account of which it had been altogether deſerted. He put ſix pounds of common ſalt into a glaſs veſſel, placed in the middle of the church, poured two pounds of ſulphuric acid on the ſalt, placed the veſſel on ſome live coals, and immediately ſhut the doors. It was allowed to remain 12 hours; after which the doors were opened; and a current of air being allowed to paſs through it, it was found that the noxious vapours were entirely deſtroyed.

540 Compounds 17. The compounds which are formed by muriatic acid, with alkalies, earths, and metallic oxides, are diſtinguiſhed by the name of *muriates*.

541 Affinities. 18. The following is the order of the affinities of this acid.

Barytes,
Potaſh,
Strontites,
Lime,
Ammonia,
Magneſia,
Glucina,
Alumina,
Metallic oxides.

SECT. VI. *Of OXYMURIATIC Acid.*

542 Hiſtory. 1. Oxymuriatic acid was diſcovered by Scheele in the year 1774, and he gave it the name of *dephlogiſticated marine acid*. On account of its ſingular properties, and the important uſes to which it was ſoon applied, it has been much examined by chemical philoſophers.

543 Method of procuring. 2. This acid is obtained by the following proceſs: Take three parts of common ſalt, and one part of the black oxide of mangneſe reduced to powder. Introduce them into a tubulated retort; place the retort in a ſand bath, and immerſe its beak under the ſurface of the water in the pneumatic trough. Pour upon it two parts of ſulphuric acid a little diluted with water. An efferveſcence takes place, and a yellow coloured gas is evolved, which may be received in jars, or preſerved in large veſſels with ground ſtoppers.

The nature of this proceſs is ſufficiently obvious. Common ſalt is compoſed of muriatic acid and ſoda; the affinity of ſulphuric acid for ſoda is ſtronger than that of muriatic acid; it therefore combines with the ſoda, and the muriatic acid is diſengaged in the ſtate of gas. The black oxide of mangneſe is compoſed of oxygen and the metallic ſubſtance. The ſulphuric acid combines with the mangneſe, and ſets the oxygen at liberty in the ſtate of gas. But there is alſo an affinity between the muriatic acid and oxygen, ſo that in the moment of evolution they unite, and paſs off in the ſtate of oxymuriatic acid gas.

544 Properties. 3. This gas is of a yellowiſh green colour, has a ſtrong penetrating odour, and excites violent coughing, when a mixture of it with atmoſpheric air is reſpired; but the pure gas is totally unfit for reſpiration. This gas ſupports combuſtion. It diminiſhes and reddens the flame of a taper; a great deal of ſmoke is evolved, and the taper conſumes very rapidly.

545 Unchanged by light and heat. 4. Neither light nor heat have any action on the gas. When paſſed through red-hot porcelain tubes, it remains unchanged.

546 Action of hydrogen gas. 5. It has no action whatever on oxygen or azotic gaſſes.

6. In the cold no effect is produced from a mixture of this gas with hydrogen gas; but when they are paſſed through a red-hot tube, there is a violent detonation.

547 Of charcoal. 7. In the cold there is no action between charcoal and this gas. When a mixture of equal bulks of this gas and carbonated hydrogen gas is ſet fire to, there is only a combuſtion of the hydrogen gas, with a depoſition of charcoal. If two meaſures of oxymuriatic acid gas, and one meaſure of carbonated hydrogen gas are mixed together in a cloſe phial, and allowed to remain for 24 hours, they decompoſe each other. Water, muriatic acid, carbonic acid, and gaſeous oxide of carbone, are the products. When water is admitted, the whole will be nearly abſorbed.

548 Of phoſphorus. 8. A bit of dried phoſphorus introduced into this gas, is inſtantly inflamed, and converted into phoſphoric acid. It alſo ſets fire to phoſphorated hydrogen gas, which has loſt the property of ſpontaneous inflammation in the air.

549 Of ſulphur. 9. Melted ſulphur, plunged into this gas, is immediately inflamed, and converted into ſulphuric acid. Sulphurated hydrogen gas is denominated, but without inflammation, and ſulphur is depoſited.

550 Sulphurous acid. 10. There is no action between this gas and ſulphuric acid; but, when ſulphurous acid gas is mixed with it, a thick white vapour is formed, which is the ſulphurous acid converted into ſulphuric acid, by depriving the oxymuriatic acid gas of its oxygen. It has no effect on nitric acid; but nitrous gas brought into contact with it, is reddened, and converted into nitrous acid.

551 In the liquid ſtate. 11. What is commonly known by the name of *oxymuriatic acid*, is water ſaturated with this gas. It has a pale green colour, and exhales the ſame odour as the gas. According to Berthollet, a cubic inch of water abſorbs $1\frac{6}{10}$ grs. French of the gas. The quantity abſorbed by the water is in proportion to the temperature and the preſſure. When veſſels containing water, and receiving this gas, are ſurrounded with ice, while the water is ſaturated, the gas cryſtallizes at the ſurface, and even at the bottom of the liquid, in the form of ſix-ſided plates, of a greeniſh white colour; but the ſlighteſt heat diſſolves them, and they riſe through the liquor in the form of gas.

Water ſaturated with this gas at the temperature of 43° has the ſpecific gravity of 1.003.

552 Deſtroys vegetable colours. 12. This acid does not redden vegetable blues, like the other acids. It has the ſingular property of deſtroying vegetable colours, on account of which it has

been much employed in the art of bleaching. The effect which takes place in this proceſs, is the combination of the colouring matter with the oxygen of the acid; for the acid which has been employed is deprived of its oxygen, and converted into muriatic acid. But for the full account of this proceſs, ſee BLEACHING.

553 Action of light. 13. When this acid is expoſed to the light, it is decompoſed; it gives out its oxygen gas, becomes colourleſs, and paſſes into the ſtate of muriatic acid. But when heat is applied, the acid is diſengaged in the ſtate of gas, without any perceptible ſeparation of its oxygen. Expoſed to the air, the acid is gradually ſeparated, exhaling, at the ſame time, its pungent, diſagreeable odour.

554 Compoſition. 14. The conſtituent parts of oxymuriatic acid, according to Berthollet, are

89 muriatic acid,
11 oxygen.
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100

But, according to the experiments of Mr Chenevix, it is compoſed of

84 muriatic acid,
16 oxygen.
———
100

Sect. VII. *Of Hyper-oxymuriatic Acid.*

555 Nature. 1. Oxygen combines in a different proportion with muriatic acid, and forms another acid, poſſeſſed of properties which are quite diſtinct from the properties of the laſt deſcribed. This acid has never been obtained in a ſeparate ſtate, but the peculiarity of its nature has been ſufficiently demonſtrated, in its combinations with other ſubſtances. As it contains a greater proportion of oxygen than the oxymuriatic acid, it has been denominated *hyper-oxymuriatic acid.*

556 How obtained. 2. It may be procured in combination with potaſh by the following proceſs. If a quantity of potaſh, with ſix times its weight of water, be put into one of the bottles of Woulfe's apparatus, and a ſtream of oxymuriatic acid gas be paſſed through it till the potaſh is ſaturated, cryſtals in the form of fine white ſcales fall to the bottom. Theſe are cryſtals of hyper-oxymuriate of potaſh, compoſed of potaſh and of hyper-oxymuriatic acid. The liquid in which theſe ſalts have been formed being evaporated to dryneſs, yields another ſalt which is compoſed of muriatic acid and potaſh.

557 Theory of the proceſs. This was the diſcovery of Berthollet; and the theory which he propoſed to account for the products that appeared in this proceſs was the following. He ſuppoſed that the oxymuriatic acid was decompoſed: part of it being deprived of its oxygen, combined in the ſtate of muriatic acid with part of the potaſh, forming the ſalt which was obtained by evaporation, namely, the muriate of potaſh; and part united with an additional portion of oxygen combined with another portion of the potaſh, and formed the ſalt which was depoſited in the liquid. This theory has been confirmed by the experiments of Mr Chenevix. According to theſe experiments the hyper-oxymuriatic acid is compoſed of

65 oxygen,
35 muriatic acid.
———
100

558 Compoſition. But its properties will be more fully detailed in conſidering its combination with potaſh, when we come to treat of that ſubſtance.

559 Affinities. 3. The order of the affinities of hyper-oxymuriatic acid, is the following, as they have been aſcertained by Mr Chenevix *.

Potaſh,
Soda,
Barytes,
Strontites,
Lime,
Ammonia,
Magneſia,
Alumina.

Sect. VIII. *Of Fluoric Acid.*

560 Hiſtory. 1. The component parts of this acid are unknown. It was diſcovered by Scheele in 1771, and by him and Prieſtley its peculiar properties, which have been confirmed by the experiments of other chemiſts, were firſt detected. Margraaff, three years before, had aſcertained that the fluor ſpar, from which this acid is obtained, differed in its properties from other ſpars. When he diſtilled equal parts of ſulphuric acid and fluor ſpar, he obtained a white ſublimate, and found that the glaſs retort which he employed in the proceſs was greatly corroded, and pierced with holes. Scheele afterwards proved by his experiments, that the fluor ſpar is compoſed of lime and the peculiar acid to which the name fluoric has been given.

561 Method of obtaining it. 2. To procure fluoric acid, put one ounce of fluor ſpar (fluate of lime) reduced to powder into a retort of tin or lead, pour over it three ounces of concentrated ſulphuric acid, and adapt to the retort a tube and receiver of the ſame metal. When the acid comes in contact with the ſpar a gas is driven off, which is the fluoric acid. Toward the end of the proceſs, if a gentle heat be applied, a greater quantity of the acid may be obtained. If water has been previouſly introduced into the receiver, the gas is abſorbed by it, and the acid may then be exhibited in the liquid ſtate.

562 Properties of this gas. 3. Fluoric acid appears under two forms, that of gas and that of a liquid.

Fluoric acid gas has the common properties of air. It is inviſible and elaſtic. Its ſpecific gravity has not been accurately determined, but it is heavier than atmoſpheric air. Expoſed to the air it combines inſtantly with the moiſture of the atmoſphere, and appears in the form of vapour or white fumes. Like muriatic acid, it has a penetrating pungent ſmell. It reddens vegetable blues, and corrodes the ſkin. It is totally unfit for reſpiration. Animals who breathe it are inſtantly deſtroyed. It is alſo unfit for the ſupport of combuſtion. But before the flame of a candle introduced into this gas is extinguiſhed, it aſſumes a greeniſh colour. The moſt remarkable property of this gas is that of corroding glaſs, in conſequence of its ſtrong affinity for the ſilex, one of component parts of glaſs. This is the reaſon that it muſt be prepared in metallic veſſels. And even with this precaution, it is ſeldom entirely free from this earth, which it probably derives from the fluor ſpar, from which it is obtained.

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* Phil. Tranſ. 1802. p. 126.

4. Light and caloric have no effect on it. Its properties undergo no alteration, even when it has paſſed through a red-hot porcelain tube.

In contact with oxygenous gas or atmoſpheric air, no changes take place on fluoric acid gas; nor has it any action on azote, hydrogen, carbone, phoſphorus, or ſulphur. The other acids, it has been obſerved, are decompoſed by one or other of theſe combuſtibles; and in this way their conſtituent parts have been detected. We are not however to conclude from thence, that the fluoric acid is a ſimple ſubſtance. On the contrary, it would be more analogous to other facts, to draw the concluſion, that it is a compound, ſimilar to the other acids, whoſe baſes have been diſcovered, and that the baſe, whatever that may be, has ſo ſtrong an attraction for oxygen as to be unſuſceptible of decompoſition by the action of any ſubſtances yet known.

563 Combines with water. 5. When this gas comes in contact with water it is rapidly abſorbed, and in conſiderable proportion. In the ſtate it is called *fluoric* acid. The ſpecific gravity of this acid is greater than that of water. By heat the gas is almoſt entirely expelled from the water; and when it is cooled down to the temperature 23° it freezes.

564 Compounds. 6. The compounds with the alkalies, earths, and metallic oxides, are called *fluates*.

565 Affinities. 7. The order of its affinities is the following:

Lime,
Barytes,
Strontites,
Magneſia,
Potaſh,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia,
Silica.

Sect. IX. *Of Boracic Acid.*

566 Diſcovery. 1. The component parts of boracic acid are unknown. It was firſt diſcovered by Homberg in 1702, who gave it the name of *narcotic* or *ſedative ſalt*. The ſubſtance called borax of the ſhops is a compound of this acid and ſoda.

567 Preparation. 2. The proceſs for obtaining this acid is the following: Diſſolve a quantity of this ſubſtance in hot water, and filter the ſolution. Gradually pour on it ſulphuric acid, till the liquor acquires a ſlight degree of acidity. The ſulphuric acid combines with the ſoda; and the boracic acid, as the ſolution cools, is precipitated in ſmall, ſhining white ſcales. To purify the acid thus obtained, it is to be waſhed with cold water, which removes the more ſoluble ſalts with which it is mixed.

568 Properties. 3. Boracic acid is in the form of ſilvery white hexagonal ſcales, which have a greaſy feel, and ſome reſemblance to ſpermaceti. It has a ſouriſh taſte, which afterwards gives the ſenſation of coolneſs. It has no ſmell. It changes vegetable blues to red. In the ſcaly form, the ſpecific gravity is 1.479, but when it is fuſed, it is 1.803.

569 Action of heat. 4. When expoſed to heat, it froths up, which is owing to the ſeparation of the water of cryſtallization, and aſſumes the form of a viſcid paſte. In this ſtate it is known by the name of *calcined borax*. When it is expoſed to a red heat, it is converted into a hard, tranſparent glaſs, which, without attracting moiſture from the air, becomes opaque when expoſed to it, but it remains unchanged; for when it is re-diſſolved in warm water, it reſumes its former properties, by cooling and cryſtallization *.

570 Of water. 5. Boracic acid has very little attraction for water; boiling water only diſſolves about a 50th part of its weight, and cold water much leſs. When the ſolution in water is evaporated in cloſe veſſels, part of the acid riſes in the ſtate of vapour along with the water, and cryſtallizes in the receiver; but when the whole of the water is diſſipated, the proceſs ſtops; ſo that it is only by means of it that the acid is volatilized; otherwiſe it is perfectly fixed. The ſolution in water has little taſte, but it reddens the tincture of turnſole.

6. Neither oxygen, azotic, nor hydrogen gaſes, produce any effect upon it; and with charcoal, phoſphorus, and ſulphur, it alſo remains unchanged. When burnt with phoſphorus, indeed, there is left behind an earthy, yellow matter.

571 On acids. 7. At a red heat it drives off ſome of the acids from their combinations, even thoſe acids which have the ſtronger affinity for the ſame ſubſtances in the cold. Boracic acid has ſome peculiar action with the ſulphuric, the nitric, and oxymuriatic acids; for when it is heated with theſe acids, it deprives them of a portion of their oxygen; but the changes which take place by this action have not been diſtinctly aſcertained †.

8. Fabroni of Florence conſiders this acid as a modification of the muriatic, and he ſuppoſes that it may be entirely formed with this acid. The boracic acid, he farther ſuppoſes, is probably produced by this modification of the muriatic acid in the water of the lakes of Tuſcany; but the facts on which this opinion is founded, have not been publiſhed ‡.

572 Uſes. 9. The boracic acid is employed in chemiſtry not directly as an inſtrument of analyſis, becauſe its affinities and action have little energy compared with other acids, but to diſcover its peculiar combinations and compounds. It is alſo employed in the arts, as in ſoldering, to aſſiſt the fuſion of metallic ſubſtances. It is of great importance to the mineralogiſt, in promoting the fuſion of ſubſtances under the blow-pipe.

573 Compounds. 10. The compounds which boracic acid forms with the alkalies, earths, and metallic oxides, are diſtinguiſhed by the name of *borates*.

574 Affinities. 11. The affinities of boracic acid are the following:

Lime,
Barytes,
Strontites,
Magneſia,
Potaſh,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia,
Water,
Alcohol.

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* *Fourcroy Connaiſs*, tom. ii. p. 125.

† *Ibid*. p. 127.

‡ *Ibid*. p. 128.

Sect. X. *Of Phosphoric Acid.*

575 Formation. 1. When phoſphorus undergoes combuſtion in oxygen gas, a great quantity of white fumes are produced, which are depoſited in white flakes. Theſe are phoſphoric acid; ſo that it is a compound of phoſphorus and oxygen.

576 Hiſtory. 2. The phoſphoric acid was firſt ſhown to be diſtinct from all other acids, in the year 1743, by Margraaff. He found that it exiſted in the ſalts which were taken from human urine, and that phoſphorus could only be obtained from this acid; as well as that it could be converted into phoſphoric acid. This acid was found to exiſt in ſome vegetable ſubſtances, although it was formerly ſuppoſed to be peculiar to animal matters. It was diſcovered by Scheele and Gahn in bones, in the year 1772. Bergman, Prouſt, and Tenant, detected it in ſeveral foſſils; and Lavoiſier proved, by a ſeries of accurate and ingenious experiments, that it was compoſed of phoſphorus and oxygen.

577 Preparation. 3. Phoſphoric acid may be obtained, not only by the method juſt mentioned, but alſo by tranſmitting a current of oxygen gas through phoſphorus melted under water. The acid as it is formed, combines with the water, from which it may be obtained in a ſtate of purity by evaporation. It may be procured alſo by dropping ſmall bits of phoſphorus into nitric acid moderately heated. An efferveſcence takes place, and nitrous gas is evolved. Phoſphorus combines with the oxygen, and forms phoſphoric acid. The precaution of adding but a little phoſphorus at a time, and of applying a moderate heat to the acid, ſhould be carefully obſerved. The liquid is then evaporated, and the phoſphoric acid remains behind in the ſolid ſtate. The water that may be combined with it is driven off, by expoſing it to a red heat.

578 Properties. 4. In this ſtate phoſphoric acid is a tranſparent, colourleſs, ſolid ſubſtance, reſembling glaſs, known under the name of *phoſphoric glaſs*.

The ſpecific gravity of this acid varies, according to the different ſtates in which it exiſts. In the liquid ſtate it is 1.417; in the dry ſtate it is 2.697; in the ſtate of glaſs 2.8516. It changes the colour of vegetable blues to red; has no ſmell, but a very acid taſte.

579 Attracts moiſture. 5. When it is expoſed to the air, it attracts moiſture, and is converted into a thick viſcid fluid, like oil. It is very ſoluble in water. When in the form of dry flakes, it diſſolves in a ſmall quantity of this liquid, producing a hiſſing noiſe like that of a red-hot iron plunged into water, with the extrication of a great quantity of heat. In the ſtate of glaſs it diſſolves more ſlowly, but the concentrated liquid phoſphoric acid unites with water with very little diſengagement of caloric.

580 Action of charcoal. 6. Phoſphoric acid being fully ſaturated with oxygen, has no action whatever on oxygen gas; nor is there any action between hydrogen or azotic gaſes, or ſulphur, with the phoſphoric acid. Charcoal has no effect on phoſphoric acid in the cold; but when they are expoſed together to a red heat, the phoſphoric acid is decompoſed; the oxygen combines with the carbone of the charcoal, forming carbonic acid, and the phoſphorus is ſet at liberty. This is the proceſs already deſcribed in treating of phoſphorus, which is generally employed for obtaining that ſubſtance.

581 Of acids. 7. Sulphuric acid has no action on phoſphoric acid; but when the two acids are mixed together in the liquid ſtate, the ſulphuric acid, on account of its ſtrong affinity for water, combines with the water in the phoſphoric acid; and if heat be applied, the ſulphuric acid is diſſipated, and the phoſphoric acid remains behind in the ſtate of a tranſparent viſcid matter, or in that of glaſs. Sulphurous acid is ſeparated from its combinations by the phoſphoric acid. Nitric acid ſeparates the phoſphoric from its combinations. Muriatic acid has the ſame effect.

582 Compoſition. 8. The component parts of this acid have been accurately aſcertained by Lavoiſier, and it conſiſts of,

60 oxygen,
40 phoſphorus.
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100

583 Importance 9. The accuracy of our information with regard to the component parts and properties of phoſphoric acid, renders it of great importance in many chemical operations; and if it could be obtained with leſs difficulty and expence, its uſes might be extended to medicine and the arts.

584 Compounds. 10. It combines with the alkalies, earths, and metallic oxides, and forms ſalts which are denominated *phoſphates*.

585 Affinities. 11. The following is the order of its affinities.

Barytes,
Strontites,
Lime,
Potaſh,
Soda,
Ammonia,
Magneſia,
Glucina,
Alumina,
Zirconia,
Metallic oxides,
Silica.

Sect. XI. *Of Phosphorous Acid.*

586 Formation. 1. Phoſphorous acid bears the ſame relation to phoſphoric as ſulphurous acid does to ſulphuric. It is combined with oxygen in the ſmaller proportion. This was demonſtrated by Lavoiſier in 1777, when he pointed out the difference between the product from the ſlow or rapid combuſtion of phoſphorus. It is obtained by the ſlow combuſtion of phoſphorus at the common temperature of the air. If phoſphorus, in ſmall pieces, be expoſed to the air in a glaſs funnel placed in a bottle, it attracts the oxygen and moiſture from the atmoſphere, and runs down into the bottle. This is the phoſphorous acid. By this proceſs, about three times the weight of the phoſphorus is obtained.

587 Properties. 2. It is then in the form of a white thick liquid, adhering to the ſides of the veſſel. It varies in conſiſtence according to the ſtate of the air. Its ſpecific

gravity is not known. It has an acid, pungent taſte, not different from phoſphoric acid. It alſo reddens vegetable blue colours.

588 Action of heat. 2. Phoſphorous acid is not altered by light. When expoſed to heat in a retort, part of the water combined with it is firſt driven off; and when it is concentrated, bubbles of air ſuddenly riſe to the ſurface, and collect in the form of white ſmoke, and ſometimes inflame, if there be any air in the apparatus. If the experiment be made in an open veſſel, each bubble of air, when it comes to the ſurface, produces a vivid deflagration, and diffuſes the odour of phoſphorated hydrogen gas. This inflammable gas continues to be evolved for a long time, and when the action ceaſes, phoſphoric acid only remains behind. It ought to be obſerved, that the phoſphorated hydrogen gas is not diſengaged till the phoſphorous acid is concentrated and brought to a high temperature, which ſeems to prove that the phoſphorus which is not ſaturated with oxygen, ſtrongly adheres to it.

589 Oxygen. 4. There is little attraction between oxygen and phoſphorous acid, which ſeems to be owing to the great affinity between phoſphorus and phoſphoric acid. It abſorbs, however, very ſlowly, a ſmall quantity of oxygen; and even after long boiling, it is not completely converted into phoſphoric acid.

590 Hydrogen. 5. Hydrogen gas has no action on phoſphorous acid; but this acid is decompoſed at a red heat, by means of charcoal, which ſeparates from it a greater quantity of phoſphorus than from phoſphoric acid. There is no action between theſe bodies in the cold. Sulphur has no action on this acid at the ordinary temperature of the atmoſphere, and they cannot be combined by means of heat, becauſe the phoſphorus is diſſipated before it unites with the ſulphur.

591 Of acids. 6. There is no action between phoſphorous acid and ſulphuric acid in the cold; but when they are heated together to the boiling temperature, the phoſphorous acid deprives the ſulphuric of part of its oxygen, and is converted into phoſphoric acid, while part of the ſulphuric acid thus decompoſed, is diſengaged in the ſtate of ſulphurous acid gas. Phoſphorous acid produces a ſimilar effect on nitric acid. The phoſphorus is converted into phoſphoric acid, and part of the nitric acid is converted into nitrous gas.

592 Compoſition. 7. This acid is compoſed of the ſame conſtituent parts as the phoſphoric, and is conſidered by ſome as the phoſphoric acid holding in ſolution a ſmall quantity of phoſphorus *.

593 Compounds. 8. Phoſphorous acid forms compounds with alkalies, earths, and metallic oxides, which are known under the name of *phoſphites*.

594 Affinities. 9. The order of its affinities is the following.

Lime,
Barytes,
Strontites,
Potaſh,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia,
Metallic oxides.

Sect. XII. *Of Carbonic Acid.*

595 Formation. 1. When a piece of charcoal, in a ſtate of ignition, is plunged into a jar of oxygen gas, it burns with great brilliancy; and after the combuſtion has ceaſed, the air in the veſſel is totally changed. If a little water is introduced into the jar, and agitated, the air combines with it; and this water, when examined, exhibits acid properties. This is *carbonic acid*. It is formed by the combination of carbone and oxygen. This is one of the moſt important acids, both on account of its numerous combinations, and alſo on account of the diſcovery of it having occaſioned a total revolution in chemical ſcience.

596 Names. 2. It was regarded by the ancients, on account of the noxious effects which it produced, as a peſtilential vapour, and they gave it the name of *ſpiritus lethalis*. Paracelſus and Van Helmont conſidered it as a peculiar matter, to which they gave the name, *ſpiritus ſylveſtris*, or *gas*. Hales, although he conſidered it merely as contaminated air, diſtinguiſhed it by the name of *fixed air*, becauſe it entered into the compoſition of many bodies. Dr Black demonſtrated, that it is a peculiar ſubſtance, different from the air; that lime, magneſia, and the alkalies, were deprived of their cauſticity, by being combined with this air, and therefore he gave it the name of *fixed air*. It was afterwards found by the experiments of Keir and Bergman, to be an acid, and hence Bergman gave it the name of *aërial acid*. The nature and properties of this acid were inveſtigated by many chemical philoſophers, and from them it received various names, as *mephitic acid*, *calcareous* or *cretaceous acid*, thus diſtinguiſhed from its effects, or from the ſubſtances from which it was obtained. In the preſent chemical nomenclature it has the name of *carbonic acid*, from its baſe *carbone*.

597 At firſt ſuppoſed ſimple. 3. For ſome time after the diſcovery of the difference between carbonic acid and common air, and its properties as an acid, it was conſidered by many as a ſimple elementary ſubſtance, and it was regarded as the acidifying principle. In the progreſs of inveſtigation it was found to be a compound ſubſtance, and that oxygen was one of its conſtituent parts, and it was generally believed that phlogiſton conſtituted the other. When hydrogen was ſubſtituted for phlogiſton, it was ſuppoſed that oxygen and hydrogen conſtituted carbonic acid. The diſcovery of Mr Cavendiſh, proved that water, not carbonic acid, was the product of the combination of oxygen and hydrogen. But the experiments of Lavoiſier have eſtabliſhed the fact, and placed it beyond diſpute. He demonſtrated that the weight of the carbonic acid which was obtained, was exactly equal to the quantity of the oxygen and charcoal which had diſappeared.

598 Method of obtaining. 4. Carbonic acid may be obtained by taking a quantity of chalk or limeſtone, or marble, and reducing them to a coarſe powder. Introduce it into a matraſs, pour over it a quantity of diluted ſulphuric or nitric acids; a violent effervescence takes place, carbonic acid gas is diſengaged, which paſſes over, and may be received in veſſels in the uſual way. The chemical action that takes place in this change muſt be obvious. The affinity of the ſulphuric acid for the lime is ſtrong-

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* Fourcroy Connaiſſ. Chim. tom. ii. p. 85. Lagrange, i. 183.

er than that of the carbonic acid, which is previouſly in combination with it; the ſulphuric acid, therefore, ſeizes the lime, and the carbonic acid is diſengaged in the ſtate of gas.

599 Properties. 5. Carbonic acid thus obtained in the ſtate of gas, is an inviſible, elaſtic fluid. Its ſpecific gravity is 0.0018. One hundred cubic inches of it weigh 46.5 grs. It is nearly double the weight of common air. It has no ſmell; it is totally unfit for reſpiration, and equally ſo for ſupporting combuſtion. It reddens the tincture of turnſole, which has its blue colour reſtored on being expoſed to the air, by the ſeparation of the acid.

600 Abſorbed by water. 6. Water abſorbs a conſiderable proportion of this acid, which is increaſed by agitation. At the temperature of 41° water abſorbs its own bulk. When artificial preſſure is employed, the quantity of gas abſorbed may be greatly increaſed. It is in this way that what are called the aërated alkaline waters are prepared, ſome of which, it is ſaid, contain no leſs than three times their bulk of the gas. Water impregnated with this gas, acquires an acidulous taſte, and when poured from one veſſel to another, has a ſparkling appearance. When water impregnated with this acid is expoſed to the air, it ſoon diſappears. The air of the atmoſphere attracts it from the water, having a ſtronger affinity for it than the water.

When water containing this gas is raiſed to the boiling temperature, the whole is driven off; and if water impregnated with it be expoſed to the temperature of 32°, the whole of the gas ſeparates during the freezing.

601 Not altered by light or heat. 7. Carbonic acid undergoes no change by the action of light. It is not changed by the action of heat in cloſe veſſels, or by paſſing it through a red-hot tube.

602 Attracted by the air. 8. There is no action between this gas and oxygen. Expoſed to the air of the atmoſphere, it is gradually diſſipated. The air of the atmoſphere generally contains from .01 to .02 parts of this gas.

603 Abſorbed by charcoal. 9. There is no action between this acid and azote. Charcoal has no chemical action on carbonic acid; but when it is heated, it has the property of abſorbing and condenſing within its pores the carbonic acid; but the acid is ſeparated by plunging the charcoal under water.

10. Phoſphorus has no action on carbonic acid; but by the aid of compound affinity, phoſphorus can decompoſe it.

11. Sulphur has ſtill leſs action on carbonic acid than phoſphorus. It is ſaid, indeed, that a ſmall quantity of ſulphur is diſſolved by this gas by means of heat, which gives it partly the fetid odour of ſulphurated hydrogen gas.

604 Diminiſhes combuſtibility. 12. Carbonic acid gas mixed with carbonated, phoſphorated, and ſulphurated hydrogen gaſes, diminiſhes the combuſtibility of theſe inflammable gaſes.

605 Compounds. 13. The carbonic acid combines with the alkalies, ſome of the earths, and metallic oxides, forming compounds known by the name of *carbonates*.

606 Affinities. 14. The following is the order of the affinities of this acid.

Barytes,
Strontites,
Lime,
Potaſh,
Soda,
Magneſia,
Ammonia,
Glucina,
Zirconia,
Metallic oxides.

607 Very abundant. 15. Carbonic acid exiſts in great abundance in nature. It is produced during the proceſſes of combuſtion and reſpiration, and the fermentation of vegetable matters. Hence it is found in pits and caverns, where there is a ſtagnation of the air, and being ſpecifically heavier than common air, it remains at the bottom. This is the reaſon why ſmall quadrupeds, as dogs, are inſtantly ſuffocated, becauſe they reſpire only this gas, when they enter places where it is accumulated. This has been long obſerved in the celebrated Grotto dell Cani in Italy, where dogs are inſtantly ſuffocated; while men, whoſe heads are in the ſtratum of common air near the top of the cavern, receive no injury. 608 Fatal effects produced by it. Men have been ſuddenly killed by going down into large vats, in which the proceſs of fermentation had been carried on. In conſequence of the greater ſpecific gravity of the carbonic acid gas, and the great quantity generated during the proceſs, when the fermented liquor is drawn off, it ſinks to the bottom of the veſſel, and there remains till it is diſplaced by a denſer fluid, or ſlowly attracted by the air. Similar accidents have happened to perſons going down into pits or wells which have been long ſhut up, and where the air has been long ſtagnant. It is by reſpiring this gas that perſons are ſuffocated who have been expoſed to the fumes of burning charcoal in cloſe places. During the combuſtion of the charcoal, the carbone combines with the oxygen of the atmoſphere; carbonic acid is formed, which ſoon fills the apartment. 609 Mode of recovery. In theſe caſes, where life is not totally extinguiſhed, the beſt method of recovery is ſaid to be, to daſh cold water on the head and body; a practice which is commonly obſerved in accidents of this kind, in northern countries, where charcoal is burnt in cloſe apartments.

SECT. XIII. *Of Arsenic Acid*.

610 Five metallic acids. 1. This acid, and the four following, have metallic ſubſtances for their baſe. Moſt metallic ſubſtances combine with oxygen in different proportions, and the compounds formed with theſe ſubſtances and oxygen, are denominated *oxides*, becauſe they poſſeſs no acid properties; but ſome of the metals combine with oxygen in greater proportion, which gives them the characteriſtic properties of acid ſubſtances.

2. The metallic ſubſtance arſenic, combines with oxygen in two proportions; the firſt, which is uſually called the *white oxide of arſenic*, has been denominated by Fourcroy, the *arſenious acid*. Macquer diſcovered ſome of the combinations of arſenic acid, previous to the year 1746; for he ſhews that a mixture of white oxide of arſenic and nitre, ſubjected to the action of a ſtrong fire, yields a neutral ſalt, to which he gave the name of the neutral ſalt of arſenic. But it was by the inveſtigation of Scheele in 1775 that its properties were fully known.

611 Proceſs for obtaining it. 3. The proceſs for obtaining it which was pointed

out by Scheele, is the following. Take three parts of the white oxide of arſenic, and diſſolve it in ſeven parts of muriatic acid. Add five parts of nitric acid to the ſolution, and diſtil it to dryneſs. The arſenic acid remains behind. It may alſo be procured by diſſolving the white oxide in liquid oxymuriatic acid, or by making a ſtream of oxymuriatic acid gas paſs through a ſolution of the white oxide of arſenic. The chemical action which takes place in theſe proceſſes, is the union of the arſenic with an additional portion of oxygen, which it derives from the nitric acid, the liquid oxymuriatic, or the oxymuriatic acid gas.

612 Properties.

4. By whatever proceſs it is obtained, the arſenic acid which is not cryſtallized has an acid, cauſtic, and metallic taſte. It reddens the ſyrup of violets, and its ſpecific gravity is 3.91. When it is expoſed to a ſtrong heat in a retort or crucible, it fuſes, attacks the glaſs of the retort, or the earth of the crucible; it remains tranſparent and pure at a high temperature, gives out a little oxygen, and is partly converted into white oxide.

5. Expoſed to the air, it attracts the moiſture from it, and abſorbs two thirds of its own weight of water from the atmoſphere, which is ſufficient to hold it in ſolution.

613 Action of water.

6. The arſenic acid is much more ſoluble in water than the white oxide. Three or four parts of water are ſufficient to diſſolve it. When it is evaporated, it aſſumes a thick conſiſtence like honey.

614 Of combuſtibles.

7. Combuſtible ſubſtances decompoſe arſenic acid, by depriving it of part of its oxygen, and converting it into the white oxide. Hydrogen gas mixed with a ſolution of this acid, has the property of precipitating it. Charcoal, phoſphorus, and ſulphur produce a ſimilar effect. Expoſed in a retort to heat with charcoal; the charcoal is inflamed, and the arſenic acid is reduced to the metallic ſtate. Sulphur heated with arſenic acid, is partly converted into ſulphurous acid gas, and partly ſublimed into the red ſulphuret of arſenic. When heated with phoſphorus, part of the phoſphorus is converted into phoſphoric acid, and the arſenic, reduced to the metallic ſtate, unites with another part of the phoſphorus, with which it forms a phoſphuret of arſenic, which ſublimes.

615 Compoſition.

8. The arſenic acid is compoſed of the white oxide of arſenic and oxygen. The proportions of its conſtituent parts, according to the experiments of Prouſt, are

65 arſenic,
35 oxygen.
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100

616 Compounds.

9. The compounds which arſenic acid forms with alkalies, earths, and ſome metallic oxides, are known by the name of *arſeniates*.

617 Affinities.

10. The order of its affinities is the following:

Lime,
Barytes,
Strontites,
Magneſia,
Potaſh,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia.

Sect. XIV. *Of Tungstic Acid.*

618 Hiſtory.

1. In the year 1781, Scheele and Bergman, in inveſtigating the nature of a heavy ſtone (called tungſten by the Swedes), diſcovered that it is compoſed of lime combined with a peculiar acid. Their diſcovery was afterwards confirmed by ſeveral chemiſts, and particularly by the experiments of the D'Elhuyarts, who detected the ſame acid in the mineral called wolfram.

619 Methods of obtaining.

2. This acid always exiſts in combination with lime and iron. It may be obtained by reducing the former to a fine powder, and treating it with nitric or muriatic acids, which unite with the lime, and then by alkalies, which diſſolve the acid. The alkaline ſolution is to be precipitated by the nitric or muriatic acid; the precipitate is to be carefully waſhed and dried, which is the tungſtic acid in the ſolid ſtate.

620 Properties.

3. Tungſtic acid thus prepared, is in the form of a white powder, which has an acid and metallic taſte; changes the colour of vegetable blues into red; and has a ſpecific gravity according to Bergman, equal to 3.600. Heated under the blow-pipe, this tungſtic acid becomes firſt yellow, then brown, and at laſt black; it affords no ſmoke, and gives no ſign of fuſion. When it is calcined for ſome time in a crucible, it is deprived of the property of diſſolving in water.

621 Action of heat.

622 Of water.

4. Expoſed to the air, it ſuffers no change. It is ſoluble in 20 parts of boiling water, but it is partially ſeparated on cooling. This ſolution has an acid taſte, and reddens the tincture of turnſole. Heated with charcoal, it is reduced, but with difficulty, to the metallic ſtate. With ſulphur and phoſphorus it becomes of a gray colour, but without reduction.

623 Of acids.

5. The acids do not diſſolve the tungſtic acid in the form of white powder, but they change completely its properties. The ſulphuric acid changes it to a blue, and the nitric and muriatic acids convert it into a fine yellow colour. In this ſtate it has loſt its taſte and ſolubility, has become ſpecifically heavier, and has acquired the property of forming ſalts with the ſame baſes diſtinctly different from thoſe formed with what was called the white acid. The Spaniſh chemiſts D'Elhuyarts, conſider the latter as an acidulous triple ſalt, and yellow oxide as real tungſtic acid.

624 Only an oxide.

6. Vauquelin and Hecht, who inſtituted a ſet of experiments on theſe oxides, as they propoſe to denominate them, obtained the ſame reſults. They conſider the tungſtic acid of Scheele as a triple ſalt, which has retained a portion of the acid by which it was precipitated in its compoſition, and when the oxide of tungſten is pure, it poſſeſſes none of the properties which are admitted and acknowledged as the characteriſtics of the acids, but that it has a ſtrong tendency to form triple combinations, in which only it exhibits acid properties. The compounds which it forms with the alkalies, earths, and metallic oxides, are a ſpecies of neutral ſalts; but the chemical combination is not fully completed to hide the alkaline properties of the former *. In forming theſe compounds, it is the only property in which it agrees with the acids. The compounds are denominated tungſtates.

625 Tungſtates.

626 Affinities.

7. The order of its affinities is the following:

Lime,
Barytes,
Strontites,

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* *Jour. de Mines*, N° xix. p. 76.

Strontites,
Magneſia,
Potaſh,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia.

Sect. XV. *Of Molybdic Acid.*

627 Hiſtory. 1. This acid was diſcovered by Scheele in the year 1778. It is a compound of the metallic ſubſtance molybdena and oxygen. Scheele ſuppoſed that it exiſted in the mineral from which he obtained it, and that this mineral was a compound of the acid, ſulphur and iron. The experiments of later chemiſts have ſhown that the acid is formed in the proceſs of preparing it, by the metal combining with oxygen.

628 Proceſſes for obtaining it. 2. There are various proceſſes for the preparation of this acid.

a. Scheele found that by treating a little of the ſulphuret of molybdena (ſulphur combined with the metal) on a ſilver plate, the white fumes which exhaled from it, adhered to the plate in form of a ſmall ſcale of a brilliant yellowiſh white colour, which was the true molybdic acid. But a very ſmall quantity can only be obtained in this way.

b. Another proceſs is by means of nitric acid. On one part of ſulphuret of molybdena in powder, pour five parts of nitric acid, and diſtil it to dryneſs. The ſame proceſs is repeated three or four times. The dry reſiduum is a white powder, which is the molybdic acid mixed with the ſulphuric acid, which is alſo formed during the proceſs with the nitric acid. The ſulphuric acid may be waſhed off with hot water, and the molybdic acid remains behind in a ſtate of purity.

c. It may be alſo prepared by projecting into a red-hot crucible three parts of nitrate of potaſh, and one part of ſulphuret of molybdena reduced to fine powder and well mixed together. A red maſs remains after the detonation compoſed of the oxide of iron, of the ſulphate of potaſh, and the molybdate of potaſh. By throwing the maſs into water, the two ſalts are diſſolved, and the oxide of iron is precipitated. Evaporate the ſolution to obtain the ſulphate of potaſh, and drop into the liquid which refuſes to cryſtallize, and which ſhould be diluted with water, ſulphuric acid, till there is no farther precipitation. The precipitate is molybdic acid, but not in a ſtate of perfect purity; for it is combined with a certain portion of potaſh.

629 Properties. 3. Molybdic acid prepared in this manner, and ſufficiently purified, is a white powder of a ſharp metallic taſte. According to Bergman, the ſpecific gravity is 3.4.

630 Action of heat. 4. When heated in a large glaſs retort, it yields a little ſulphurous acid. But when it is expoſed to a ſtrong heat in a cloſe veſſel, it fuſes, attaches itſelf to the ſides of the veſſel, and cryſtallizes on cooling in rays going out from a centre. But if at the moment the acid is in fuſion the veſſel be uncovered, it riſes into a white ſmoke by contact with air, and this vapour attaches itſelf to cold bodies in form of brilliant ſcales of a golden-yellow colour.

631 Of water. It is readily ſoluble in warm water. One part of the acid requires about 500 grs. the ſolution is of a yellow colour, has little ſmell, and reddens litmus paper.

632 Of charcoal and ſulphur. 5. Molybdic acid is decompoſed by charcoal, with the aſſiſtance of heat; it is alſo decompoſed by ſulphur, with the extrication of ſulphurous acid, and the formation of ſulphuret of molybdena.

633 Of acids. 6. The concentrated ſulphuric acid diſſolves a conſiderable quantity of molybdic acid, with the aid of heat. The ſolution on cooling becomes of a violet blue colour, which diſappears when it is heated. The muriatic acid diſſolves a conſiderable proportion by boiling. When this ſolution is diſtilled to dryneſs, one part of the acid is ſublimed, of a blue and white colour. The nitric acid has no effect whatever *.

634 Compounds. 7. Molybdic acid combines readily with the alkaline and earthy baſes, which have the name of *molybdates*.

8. This acid has not been applied to any uſe.

Sect. XVI. *Of Chromic Acid.*

635 Diſcovery. 1. This acid was diſcovered by Vauquelin in the year 1797. It has only been found in ſmall quantity, in combination with lead or iron.

636 Preparation. 2. Chromic acid may be obtained by boiling the red lead ore of Siberia in a ſolution of carbonate of potaſh, and precipitating it by means of another acid, which has a ſtronger attraction for the potaſh. A red or yellow orange powder falls to the bottom, which is chromic acid.

3. It has an acrid and peculiar metallic taſte, more perceptible than any other metallic acid.

4. When expoſed to the action of light and caloric, in open veſſels, it aſſumes a green colour; but in cloſe veſſels, it gives out pure oxygen gas, and loſing its acid properties it returns to the ſtate of green oxide. This is the only metallic acid, which by the action of caloric, eaſily parts with its oxygen.

637 Action of charcoal. 5. Strongly heated with charcoal, chromic acid becomes black, and is eaſily reduced to the metallic ſtate without fuſion. It is probable alſo, that it may be decompoſed with equal facility by hydrogen, phoſphorus, and ſulphur.

638 Water. 6. Chromic acid is ſoluble in water, and cryſtallizes by cooling and evaporation, in priſms of a ruby red colour.

639 Muriatic acid. 7. The muriatic acid by diſtillation with a moderate heat with the chromic acid, paſſes to the ſtate of oxymuriatic acid, and the mixture acquires the property of diſſolving gold. In this reſpect it reſembles the nitric acid, and it is the only metallic acid which is diſtinguiſhed by this property.

640 Compounds. 8. The chromic acid combines readily with the alkalies, and has the peculiar property of giving an orange colour to the cryſtals: from this it derived its name. The compounds are called *chromates*.

641 Uſes. 9. The chromic acid, from its peculiar colour, and the beautiful colours which it communicates to other bodies, promiſes to be uſeful in painting on porcelain and glaſs, or even in dyeing.

Sect. XVII. *Of Columbic Acid.*

642 Diſcovery. 1. The laſt of the metallic acids is the columbic, which was diſcovered by Mr Hatchet in 1801. In

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* *Phil. Tranſ.* 1789. p 389.

the ore from which it was extracted, it is combined with oxide of iron, from which it was ſeparated, by

643 Preparation.

expoſing it to a ſtrong red heat, with five times its weight of carbonate of potaſh. The alkali combined with part of the acid, and from this it was ſeparated by water. By repeatedly fuſing the reſiduum with potaſh, he ſeparated the whole of the acid from the iron, which latter combined with muriatic acid that was added to it. By treating the alkaline ſolution with nitric acid, a precipitate of a white, flaky, inſoluble ſubſtance was obtained. This is the columbic acid.

644 Properties.

2. It is of a pure white colour, but not very heavy, and has ſcarcely any perceptible taſte; it is not ſoluble in boiling water. When ſome of the powder is placed

645 Action of heat.

upon litmus paper, moiſtened with diſtilled water, the paper in a few minutes becomes red. When expoſed to the blow-pipe, it is not fuſible, but only becomes of a leſs brilliant white.

646 Of acids.

3. It is diſſolved in boiling ſulphuric acid, and forms a tranſparent colourleſs ſolution, which is only permanent while the acid is in a concentrated ſtate; for if it be diluted with water, it aſſumes a milky appearance; a white precipitate is depoſited, which, as it dries on the filter, changes when completely dry to a browniſh gray. It is then inſoluble in water, has no taſte, is ſemitranſparent, and breaks with a gloſſy, vitreous fracture. This compound appears to be formed of the ſulphuric and columbic acids. Nitric acid has no effect on the columbic acid *.

SECT. XVIII. *Of Acetic Acid.*

647 Hiſtory.

1. Acetic acid, or vinegar, was one of the earlieſt known. This indeed was to be expected, from the manner and the abundance in which it is produced, as it is the firſt change to which wine and ſimilar liquids are ſubject. The ſourneſs which exiſts in theſe liquids, is owing to the production of this acid. It has different names, according to the ſtate in which it is found.

648 Names.

When it is firſt prepared, it is known under the name of *vinegar;* when purified by diſtillation, it is called *diſtilled* vinegar; and when it is ſtrongly concentrated, it is called *radical* vinegar, or *acetic acid.*

649 Preparation.

2. The proceſs by which vinegar is obtained is the fermenting proceſs of many vegetable matters, what is uſually denominated the acetous fermentation, or the ſecond ſtage of the fermentative proceſs of vegetable matter. The circumſtances in which this fermentation takes place are, a temperature between 70° and 80°, the addition of ſome fermenting ſubſtance, and expoſure to the air.

The proceſs which is recommended by Boerhaave, is generally followed. Two large hogſheads are prepared, by fixing about a foot from the bottom, a grating of rods, on which vine branches are to be placed. The wine to be fermented is poured into the veſſels; the one is to be filled to the top, and the other only one half. They are both left expoſed to the air, Fermentation begins in the veſſel which is half full; when it is completely begun, fill it up from the other veſſel, which interrupts the fermentation in the full hogſhead, and it commences in that which is half full. When this has continued for a little time, it is filled up from the other veſſel, in which the fermentation again commences, and is interrupted in the other. Thus, the proceſs is carried on by alternately emptying and filling the veſſels till vinegar is formed, which generally requires a period of from 12 to 15 days.

650 Properties.

3. Vinegar is generally of a yellowiſh colour, an acid taſte, and agreeable ſmell. It reddens vegetable blues, and when it is expoſed to heat, it is entirely diſſipated. The ſpecific gravity varies from 1.005 to 1.0251. It varies conſiderably in colour, ſpecific gravity, and other properties, according to the ſubſtances from which it has been obtained. Vinegar in this ſtate is extremely apt to be decompoſed. Scheele has pointed out a very ſimple proceſs, by which it may be preſerved for a long time. Put the vinegar into bottles, and place them over the fire in a veſſel filled with water. Let the water boil for a moment, and then take out the bottles, after which it may be kept for ſeveral years.

651 Purified by diſtillation.

4. To ſeparate the impurities with which vinegar is contaminated, it is diſtilled with a moderate heat; the temperature muſt not exceed that of boiling water, and the proceſs ſhould be carried on only till about $\frac{2}{3}$ of the quantity have paſſed over. This is diſtilled vinegar, or the acetous acid of the chemiſts. It is then perfectly tranſparent and colourleſs, has an agreeable odour, and a ſtrong acid taſte. The vinegar in this ſtate, when expoſed to a ſufficient degree of cold, is partly frozen. As the ice which is formed conſiſts almoſt entirely of water, when it is ſeparated the fluid which remains is the vinegar highly concentrated.

652 Of radical vinegar.

5. To prepare what has been denominated radical vinegar, a ſalt of which this acid forms a component, part muſt be decompoſed. The acetate of copper, or verdigris, is generally employed for this purpoſe. It is reduced to powder, and diſtilled in a retort with a ſtrong heat. The liquid which firſt comes over is inſipid and colourleſs, and muſt be kept ſeparate from the remaining part of the product, which is the acetic acid in a highly concentrated ſtate. It has generally a green colour, being contaminated with a little copper, but it may be purified by diſtillation with a moderate heat, by which it is rendered colourleſs.

653 Acetous and acetic acids ſuppoſed to be different.

6. The acid in this ſtate was at firſt conſidered by chemiſts as different from the acetous acid in its properties, affinities, and in the compounds it forms with other bodies. This was the opinion of the celebrated chemical philoſopher Berthollet, and this opinion was adopted by almoſt all chemiſts. It was ſuppoſed that it was the acetous acid in combination with another portion of oxygen, and hence it was denominated, according to the preſent nomenclature, *acetic acid.*

654 Found to be the ſame.

7. The nature and properties of theſe two ſuppoſed acids were at laſt inveſtigated fully by Adet and Darracq, who proved that there was no difference in the proportion of oxygen in the acetous and acetic acids. This concluſion was controverted by Chaptal and Dabit, who endeavoured to ſupport the opinion of Berthollet, that the two acids are diſtinguiſhed from each other by different properties and different combinations with other bodies. It is now generally admitted, that what have been called the acetous and acetic acids, are eſſentially the ſame, their apparent differences depending on the quantity of water, mucilage and other ſubſtances with which the acetous acid is combined.

655 Properties.

8. This acid when pure, is tranſparent and colourleſs.

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* *Phil. Tranſ.* 1802. p. 44.

leſs. In the ſtate of acetous acid, it has an agreeable, aromatic odour. In the ſtate of acetic acid, or when it is highly concentrated, it acquires a ſharp, penetrating odour, different from that of the vinegar, and in this ſtate it is extremely acid. Applied to the ſkin it reddens and deſtroys it. It is highly volatile; and when expoſed to the open air, it is ſoon diſſipated. When heated in contact with the air, it inflames.

656 Cryſtallizes.

657 Action of heat.

9. This acid may be obtained in cryſtals, by forming diſtilled vinegar into a paſte with charcoal, and ſubjecting the mixture to a temperature which does not exceed 212°. By this heat the watery part is diſſipated, and the acid remains behind; but when a ſtronger heat is applied, the acid itſelf is driven off. By repeating the proceſs the acid may be obtained cryſtallized.

10. Acetic acid undergoes no perceptible change by the action of oxygen, hydrogen, or azotic gaſes; and it is not altered by charcoal, phoſphorus, or ſulphur.

658 Of acids.

11. Acetic acid is decompoſed by the ſulphuric acid. It abſorbs carbonic acid, and diſſolves boracic acid. It is alſo decompoſed by nitric acid, and is converted into carbonic acid and water. Dr Higgins analyzed the acetic acid by decompoſing it in combination with an alkali. He diſtilled in a glaſs retort 7680 grs. of acetate of potaſh, that is, potaſh combined with acetic acid, and he obtained the following products.

659 Analyſis.

Potaſh, - -	3862.9940
Carbonic acid gas,	1473.5640
Carbonated hydrogen gas	1047.6018
Charcoal, -	0078.0000
Oil, - -	0180.0000
Water, - -	0340.0000
Deficiency, -	0726.9402

Dr Higgins was at a loſs to account for this deficiency, till by repeated experiments he found that it is always owing to the water and oil, and chiefly to the water which is carried off by the elaſtic fluids. He ſtates the quantity of water carried off in vapour at 700 grs. and the quantity of oil carried off in the ſame way at 26.9402, which together make up the whole deficiency †. The potaſh remained behind unaltered; the acetic acid, therefore, has been decompoſed, and has yielded the products which were obtained by diſtillation. But the conſtituent principles of theſe products are oxygen, hydrogen, and carbone; and from the proportions of oxygen and carbone which enter into the compoſition of carbonic acid, the proportions of carbone and hydrogen in carbonated hydrogen gas, and of oxygen and hydrogen in the compoſition of water, 100 parts of acetic acid are compoſed of about

660 Compoſition.

50 oxygen,
36 carbone,
14 hydrogen.
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100

661 Compounds.

12. The compounds which acetic acid forms with alkalies, earths, and metallic oxides, are denominated *acetates*.

662 Affinities.

13. The order of its affinities is the following.

Barytes,
Potaſh,
Soda,
Strontites,
Lime,
Ammonia,
Magneſia,
Metallic oxides,
Glucina,
Alumina,
Zirconia.

SECT. XIX. *Of OXALIC ACID.*

663 Found in plants.

1. This acid exiſts ready formed in the *oxalis acetoſella* or wood-ſorrel, and ſome other ſpecies belonging to the ſame genus of plants. From this it derives the name of *oxalic acid*. It was originally denominated the *ſaccharine acid*, or the acid of ſugar, becauſe it was obtained from that ſubſtance. Its properties were firſt particularly inveſtigated by Bergman and Scheele, and the method of preparing it is given by the former.

664 Method of obtaining.

2. An ounce of white ſugar in powder is put into a retort, with three ounces of ſtrong nitric acid. During the ſolution, a great quantity of fumes of the nitrous acid eſcapes. Apply heat till the liquor boils, and nitrous gas is then driven off. When the liquor in the retort acquires a reddiſh brown colour, add three ounces more of nitric acid; continue the boiling till the fumes ceaſe, and the colour of the liquor vaniſhes. Pour out the liquor into a wide ſhallow veſſel; and, when it cools, cryſtals will be formed in ſlender four-ſided priſms, which may be collected and dried on blotting paper. The cryſtals thus obtained may be again diſſolved in diſtilled water, and evaporated to obtain new cryſtals. Oxalic acid may be obtained by a ſimilar proceſs from other vegetable, and from ſome animal ſubſtances, as gum arabic, alcohol and honey.

665 Properties.

3. Prepared in this way, oxalic acid is in the concrete ſtate, cryſtallized in four-ſided priſms, terminating in two-ſided ſummits. They are white and tranſparent, and have conſiderable luſtre. They have a ſtrong ſharp taſte, and change vegetable blues into a red colour, and produce the ſame effect on all vegetables except the indigo.

The acid properties of this ſubſtance are ſo ſtrong, that one part of concrete oxalic acid gives to 3600 parts of water, the property of reddening paper ſtained with turnſole.

666 Action of heat.

4. When oxalic acid is expoſed to heat, it is volatilized, partly in a liquid, and alſo in a ſolid and cryſtalline form. It is not decompoſed, but at a high temperature; but, when it is expoſed to a moderate heat, it dries, is covered with a white cruſt, and is ſoon reduced to powder. It loſes $\frac{1}{10}$ of its weight when put upon burning charcoal; it exhales a pungent, irritating ſmoke, and there remains behind a white alkaline reſidue.

667 Of water.

5. This acid is deliqueſcent in the air, when it is loaded with moiſture. Cold water diſſolves about $\frac{1}{2}$ its weight of the acid; boiling water diſſolves a quantity equal to its own weight.

668 Compoſition.

6. Oxalic acid is decompoſed by the ſulphuric acid with the aſſiſtance of heat, and charcoal is depoſited;

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† Experiments and Obſervations, p. 27.

at the boiling temperature it is decompoſed by the nitric acid, and converted into water and carbonic acid. According to Fourcroy, the component parts of oxalic acid, as they have been aſcertained by him and Vauquelin, are

77 oxygen,
13 carbone,
10 hydrogen.

100 *

668 Compounds. 7. Oxalic acid combines with the alkalies, earths, and metallic oxides, and the ſalts thus formed are diſtinguiſhed by the name of *oxalates*.

669 Affinities. 8. The affinities of this acid are in the following order:

Lime,
Barytes,
Strontites,
Magneſia,
Potaſh,
Soda,
Ammonia,
Alumina.

SECT. XX. *Of TARTARIC ACID.*

670 Hiſtory. 1. This acid was procured by Scheele in a ſeparate ſtate, in the year 1770, the proceſs for which he communicated to M. Retzius, who publiſhed the account of it in the Swediſh Memoirs for that year. It was the firſt diſcovery in the bright career of that diſtinguiſhed chemiſt.

671 Preparation. 2. The proceſs which he followed was by boiling a quantity of the ſubſtance called *tartar*, or *cream of tartar*, in water, and adding powdered chalk till efferveſcence ceaſes, and the liquid no longer reddens vegetable blues. It is then allowed to cool; the liquor is filtered; and a white inſoluble powder remains on the filter, which is carefully removed and well waſhed. This is put into a matraſs, and a quantity of ſulphuric acid, equal in weight to the chalk employed, diluted with water, is poured upon it. The mixture is allowed to digeſt for 12 hours on a ſand bath, ſtirring it occaſionally with a glaſs rod. The ſulphuric acid combines with the lime, and forms a ſulphate of lime, which falls to the bottom. The liquid contains the tartaric acid diſſolved in it. This is decanted off, and a little acetate of lead is dropt into it, as a teſt to detect the ſulphuric acid, ſhould any remain. With it it forms an inſoluble precipitate; and if this be the caſe, it muſt be digeſted again with more *tartrate of lime*, to carry off what remains of the ſulphuric acid. It is then evaporated, and about $\frac{1}{3}$ of the weight of tartar employed is obtained, of concrete tartaric acid. To purify this, the cryſtals may be diſſolved in diſtilled water, and again evaporated and cryſtallized. It ſeems probable, Fourcroy obſerves, that this acid exiſts in a ſtate of purity in ſome vegetables. Vauquelin has found a 64th part in the pulp of the tamarind.

672 Cryſtals. 3. Tartaric (or tartarous) acid thus obtained, is in the form of very fine needle-ſhaped cryſtals; but they have been differently deſcribed by different chemiſts. According to Bergman, they are in the form of ſmall plates attached by one extremity, and diverging at the other. They have been found by others grouped together in the ſhape of needles, pyramids, regular ſix-ſided priſms, and ſquare and ſmall rhomboidal plates. The ſpecific gravity is 1.5962.

673 Properties. 4. This acid has a very ſharp, pungent taſte; diluted with water, it reſembles the taſte of lemon juice; and it reddens ſtrongly blue vegetable colours.

674 Action of heat. 5. When it is expoſed to heat on burning coals, it melts, blackens, emits fumes, froths up, and exhales a ſharp, pungent vapour. It then burns with a blue flame, and leaves behind a ſpongy maſs of charcoal, in which ſome traces of lime have been detected. Four ounces of the concrete cryſtallized acid, carefully diſtilled, gave the following products *:

Cub. In.
431 carbonic acid gas,
120 carbonated hydrogen gas.

675 Action of heat. 6. In the decompoſition of tartaric acid by heat, one of the moſt remarkable products which particularly characterizes it, is an acid liquid of a reddiſh colour, which amounts to one-fourth part of the weight of the former. This was formerly known by the name of pyrotartarous acid. It has a ſlightly acid taſte, produces a diſagreeable ſenſation on the tongue, is ſtrongly empyreumatic, and reddens the tincture of turnſole. But it has been found by the experiments of Fourcroy and Vauquelin, to be the acetic acid impregnated with an oil † (Q).

676 Water. 7. Tartaric acid is very ſoluble in water. The ſpecific gravity of a ſolution formed by Bergman, was found to be 1.230. This ſolution in water is not liable to ſpontaneous decompoſition, unleſs it is diluted. While it is concentrated, it loſes nothing of its acid nature or its other properties.

677 Converted into oxalic. 8. Bergman ſuppoſed that tartarous acid could not be changed by the ſtrongeſt mineral acids, and more eſpecially by the nitric; but Hermſtadt has ſucceeded in converting it into oxalic acid by ſeveral ſucceſſive diſtillations, with ſix times its weight of nitric acid. Three hundred and ſixty parts of tartaric acid yielded 560 parts of oxalic acid, which ſhews that it had combined with a great additional proportion of oxygen ‡.

678 Compoſition. 9. According to the analyſis of Fourcroy and Vauquelin, 100 parts of this acid are compoſed of

70.5 oxygen,
19.0 carbone,
10.5 hydrogen.

100.0

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* *Connaiſs. Chim.* tom. vii. p. 225.

* *Fourcroy Connaiſs. Chim.* tom. vii. p. 255.

† *Ann. de Chim.* tom. xxxv. p. 161.

‡ *Fourcroy Connaiſs. Chim.* tom. vii. p. 256.

(Q) The pyromucous and the pyroligneous acids are to be regarded in the ſame light. The peculiar properties which were ſuppoſed to diſtinguiſh them from other acids, were found by the ſame philoſophers to be owing to a ſimilar impregnation.

679 Affinities. 10. The affinities of this acid are in the following order.

Lime,
Barytes,
Strontites,
Magneſia.
Potaſh,
Soda,
Ammonia,
Alumina.

SECT. XXI. *Of Citric Acid.*

680 Found in fruits. 1. The ſour or acid taſte of the juice of lemons and oranges is well known. This is *citric acid*, but it is mixed with water and mucilage; and various proceſſes have been propoſed to obtain it in a ſtate of purity.

681 Preparation. 2. The firſt which ſucceeded was propoſed by M. Georgius, an account of which was publiſhed in the Swediſh memoirs for the year 1774. His proceſs was the following. It conſiſted in filling bottles with lemon juice, ſhutting them up cloſe, and placing them for ſome time in a cellar to ſeparate the mucilage. He afterwards expoſed it to a temperature of about 24°; the watery part froze, and carried with it a portion of mucilage. This was removed, and the liquid part which remained was again frozen, till the ſolid part had a perceptible acid taſte. The juice thus reduced to one-eighth part of its original bulk, is eight times ſtronger, and requires the ſame quantity of potaſh for ſaturation. In this ſtate of concentration it was preſerved.

682 Proceſs of Scheele. 3. But in this ſtate it is not pure. We are indebted to Scheele for the diſcovery of the proceſs by which it is obtained in a ſtate of purity, and for aſcertaining the characters by which it is diſtinguiſhed from tartaric acid, with which it was formerly confounded. Lemon juice which has been filtered, is ſaturated with powdered chalk. While the chalk is added, an effervеſcence takes place, which is owing to the combination of the citric acid with the lime, and the ſeparation of the carbonic acid from it in the ſtate of gas. When the effervеſcence ceaſes, a white powder falls to the bottom. This is the lime combined with the citric acid. Waſh this powder with warm water till it paſſes off colourleſs, then put the ſalt which has been waſhed into a matraſs with a little water. Take ſuch a quantity of concentrated ſulphuric acid diluted with ſix or ſeven parts of water as may be neceſſary to ſaturate the lime which has been employed; boil it for a few minutes, then let it cool, and filter the liquor. The ſulphate of lime formed by the decompoſition of the calcareous citrate, remains upon the filter. The filtered liquor contains the pure citric acid, which is to be evaporated to the conſiſtence of a ſyrup, and to be ſet by in a cool place to cryſtallize. The citric acid is thus obtained in ſmall cryſtals.

683 Exceſs of acid to be added. Scheele thinks that it is neceſſary to add a ſmall exceſs of ſulphuric acid, to take up the whole of the lime from the citric acid. But Dizè is of opinion that this exceſs of ſulphuric acid is only neceſſary, to deſtroy the remaining portion of mucilage which adheres to the citric acid, and thus to ſeparate from it every extraneous ſubſtance *.

684 Suppoſed to be unneceſſary. But it has been obſerved, that when an exceſs of ſulphuric acid is employed, it may act upon the citric acid itſelf, decompoſe it, and produce the black matter which was ſuppoſed to be owing to the mucilage which adhered to it. And it appears, from an inveſtigation by Prouſt on the preparation of this acid, that when too much ſulphuric acid is employed, it decompoſes the citric acid, and prevents it from cryſtallizing. To prevent this, a ſmall quantity of chalk is added. He found that four ounces of chalk were neceſſary for the ſaturation of 94 ounces of lemon juice, and that the product which he obtained amounted to 7½ ounces of citrate of lime; and to decompoſe this, he added 20 ounces of diluted ſulphuric acid †.

685 Properties. 4. When citric acid is pure, it cryſtallizes in rhomboidal priſms, whoſe ſides are inclined to each other at angles of 60° and 120°, terminating at each end in four trapezoidal faces which include the ſolid angles. By ſlow cooling of large quantities of the ſolution of the pure acid, evaporated to the conſiſtence of ſyrup, Dizè obtained very fine cryſtals.

5. Citric acid has a very ſtrong acid taſte, and even ſeems to be cauſtic; but when it is diluted with water, the taſte is cooling and agreeable. It has a very ſlight odour of lemons, and it reddens blue vegetable colours.

686 Action of heat. 6. When expoſed to heat, it melts rapidly in its own water of cryſtallization. When the ſolid acid is put upon burning coals, it quickly fuſes, froths up, exhales a ſharp, penetrating vapour, and is reduced to the ſtate of charcoal. Diſtilled in a retort, it is partly diſengaged without decompoſition, ſeems to be converted partly into vinegar, and then yields carbonic acid gas, carbonated hydrogen gas, and there remains in the retort a maſs of light charcoal.

687 Water. 7. Expoſed to the air, it effloreſces in a dry, warm atmoſphere; but when the air is moiſt, it abſorbs water, and loſes its cryſtalline form. It is very ſoluble in water. Seventy-five parts of water diſſolve 100 of the acid.

688 Acids. 8. Sulphuric acid, when concentrated, converts it into acetic acid. It is alſo decompoſed by the nitric acid, which converts it partly into oxalic acid, but the greater proportion into acetic acid.

689 Compoſition. 9. From the experiments which have been made with this acid, by decompoſing it by means of other acids, and the products which it affords, and its converſion into acids whoſe component parts are known, it ſeems to be pretty certain that oxygen, hydrogen, and carbone enter into the compoſition of citric acid.

690 Compounds. 10. This acid enters into combination with alkalies, earths, and metallic oxides, and forms ſalts which are denominated *citrates*.

691 Affinities. 11. The affinities of citric acid are the following.

Lime,
Barytes,
Strontites,
Magneſia,
Potaſh,
Soda,
Ammonia,
Alumina,
Zirconia.

SECT.

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* *Fourcroy Connaiſs Chim.* tom. vii. p. 204.

† *Journ. de Phyſ.* lii. p. 369.

SECT. XXII. *Malic Acid.*

692 Hiſtory.

1. Malic acid is found in conſiderable proportion in the juices of a great number of fruits. In them it exiſts ready formed, and particularly in the juice of apples, from which it has derived its name. In ſome fruits it exiſts in ſmall quantity, mixed with a great proportion of citric acid, as in two ſpecies of *vaccinium, oxycoccos* and *vitis idæa, prunus padus*, and *ſolanum dulcamara*. Theſe acids are found in nearly equal proportions in ſome other fruits, as in the gooſeberry, cherry, and ſtrawberry; but it exiſts in greateſt abundance, and in the greateſt purity, in the juice of apples.

693 Method of preparing it.

2. It is prepared by the following proceſs, which was diſcovered by Scheele. Bruiſe a quantity of four apples, expreſs the juice, and filter it through a linen cloth. Saturate this juice with potaſh, add to the ſolution acetate of lead (ſugar of lead) diſſolved in water, and continue the addition till there is no more precipitation. The acetic acid combines with the potaſh, and remains in the liquid, while the malic acid unites with the lead, and being inſoluble, falls to the bottom. Waſh the precipitate with water, and pour upon it diluted ſulphuric acid. The ſulphuric acid combines with the lead, and forms an inſoluble ſalt, which falls to the bottom. The malic acid remains uncombined in the liquid. Care ſhould be taken to add a ſufficient quantity of the ſulphuric acid to ſeparate the whole of the malic acid from the lead, which may be known by the pure acid taſte unmixed with the ſweet taſte of the ſalt of lead.

694 Of ſeparating from citric.

3. When this acid is mixed with citric acid, as is the caſe in the juices of many fruits, Scheele contrived the following proceſs to ſeparate them. The juice is firſt evaporated to the conſiſtence of honey; alcohol is poured upon it, by which the two acids are diſſolved, and a great quantity of mucilage is ſeparated; the alcohol is then evaporated; the reſidue after evaporation is diluted with two parts of water, and ſaturated with chalk, which combines with both the acids. The citrate of lime, which is the leaſt ſoluble, is ſeparated by evaporation; the malate of lime, or the combination with the malic acid, may be alſo ſeparated, by adding another portion of alcohol, which does not diſſolve the ſalt, but a ſaccharine matter which had combined with the malate of lime. The malic acid may then be ſeparated as before, with the ſolution of the ſugar of lead.

695 Obtained from houſe leek.

4. Vauquelin has extracted a very pure and nearly colourleſs malic acid from the juice of houſe-leek, (*ſempervivum tectorum*, Lin.) It exiſts in this juice combined with lime. He extracted it by evaporating the juice, pouring alcohol upon the reſidue to ſeparate a ſmall quantity of ſugar which it contained, and by adding to the remaining matter an equal weight of concentrated ſulphuric acid, previouſly diluted with ſeven or eight times the quantity of water. But as ſome traces of ſulphate of lime are always found in the malic acid prepared in this way, he prefers the following method.

Add to the juice, a ſolution of ſugar of lead; a precipitate is formed, which is to be decompoſed by means of diluted ſulphuric acid *.

5. Malic acid thus obtained, is a reddiſh brown liquid, of a pungent acid taſte, leaving afterwards the ſenſation of ſweetneſs. It reddens blue vegetable colours. It never aſſumes a cryſtalline form, but becomes thick and viſcid like ſyrup; and when expoſed to dry air, it dries in thin ſtrata like a brilliant varniſh, for which purpoſe it might be employed on poliſhed ſurfaces †.

696 Properties.

697 Action of heat.

6. Malic acid is very readily decompoſed by heat. It becomes of a dark colour, ſwells up, exhales a thick acrid vapour in the open air, and leaves behind a bulky maſs of coal. When diſtilled in a retort, it yields an acid water, a great deal of carbonic acid gas, a little carbonated hydrogen gas, and a light ſpongy coal.

698 Decompoſed ſpontaneouſly.

7. It is ſpontaneouſly decompoſed in the veſſels in which it is kept; undergoes a kind of vinous fermentation, and depoſits a mucous, flaky ſubſtance. This decompoſition is owing to the intimate re-action of its conſtituent parts.

699 by nitric acid.

8. All the ſtrong acids decompoſe it. Concentrated ſulphuric acid chars it; and it is converted into oxalic acid by nitric acid. Scheele diſcovered, that mucous matters treated with nitric acid, paſſed to the ſtate of malic acid, or were converted into this acid, and into oxalic acid.

700 Proportion of its conſtituents unknown;

9. The proportions of the conſtituent parts of this acid have not been aſcertained; but from its decompoſition, and the products which are thus obtained, it is obvious that it is compoſed of oxygen, hydrogen, and carbone, of which the latter is ſuppoſed to be in great proportion.

701 and alſo its affinities.

10. The affinities of this acid are not determined. The compounds which it forms with alkalies, earths, and metallic oxides, are denominated *malates*.

11. It is very ſoluble in water.

SECT. XXIII. *Of Gallic Acid.*

702 Hiſtory

1. This acid exiſts moſt abundantly in a well known ſubſtance, *nut galls*, and hence it has obtained the name of gallic acid. It is alſo found in the bark and wood of many other plants. It was firſt examined by the academicians of Dijon in 1772, and its acid properties clearly aſcertained; but it is to Scheele that we are indebted for the diſcovery of the proceſs by which it may be obtained pure and cryſtallized. The account of this proceſs was publiſhed in 1780, which is the following.

703 Preparation.

2. To one part of nut galls, reduced to a coarſe powder, add ſix parts of pure water. Let the infuſion macerate for 15 days at the temperature of between 70° and 80°; filter it, and put the liquid into a large glaſs or earthen veſſel, expoſe it to the air, and allow it to evaporate ſlowly. A thick glutinous pellicle forms on the top; a great quantity of mucous flakes are precipitated, and the ſolution has no longer an aſtringent, but a perceptibly acid taſte. At the end of two or three months, Scheele had obſerved on the ſides of the veſſels in which the ſolution was contained, a brown cruſt covered with ſhining cryſtals of a yellowiſh gray colour. He found alſo a great quantity of theſe cryſtals under the thick pellicle which covered the liquid. He then decanted it, and added alcohol to the precipitate, the pellicle and the cryſtal-

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* *Ann. de Chim* [illegible] p. 127.

† *Fourcroy Connaiſs. Chim.* [illegible]m. v.i. p. [illegible]99.

line cruſt, and applied heat. The alcohol diſſolved the cryſtallized acid, without touching the mucilage. The ſolution was now evaporated, and the gallic acid was obtained pure, in ſmall ſhining cryſtals, of a yellowiſh gray colour.

704 Another proceſs. 3. Deyeux has pointed out another method by which with proper precautions, gallic acid may be more readily obtained. He introduces into a large glaſs retort, a quantity of nut galls reduced to powder, and applies heat ſlowly and cautiouſly, by which he obtains a large quantity of laminated, brilliant, ſilvery cryſtals, ſufficiently large, and which have all the properties of gallic acid. But in following this proceſs, it is neceſſary to obſerve, that the heat muſt be very moderate, and not continued till an oil is diſengaged, which inſtantly diſſolves all the cryſtals ſublimed before its appearance *.

705 Davy's. 4. Mr Davy prepares it by boiling together for ſome time carbonate of barytes, and a ſolution of gall nuts. This affords a bluiſh green liquor. When diluted ſulphuric acid is dropt into it, it becomes turbid; ſulphate of barytes is depoſited, and after filtration, if the ſaturation of the earth be complete, a colourleſs ſolution of gallic acid, apparently pure, is obtained †.

706 Properties. 5. Gallic acid is cryſtallized in tranſparent octahedrons, or brilliant plates; it has a ſharp, pungent, and auſtere taſte, but leſs ſtrong and aſtringent than that of the gall nut.

707 Action of water. 6. This acid is not ſenſibly affected by expoſure to the air. It requires 24 parts of cold water, and about two-thirds of its weight of boiling water, to diſſolve it, from which it can only be cryſtallized by a very ſlow evaporation.

708 Of heat. 7. With a moderate heat, it riſes into vapour, which on cooling is condenſed and cryſtallized. In the ſtate of vapour, it has a ſharp, aromatic odour, reſembling that of the benzoic acid. Every time that it is ſublimed, even with a moderate heat, it is partially decompoſed; water is formed, an acid liquid, carbonic acid gas, carbonated hydrogen gas, and ſome drops of a brown coloured oil; and there remains behind, a great quantity of coaly matter.

709 Of acids. 8. Concentrated ſulphuric acid decompoſes and chars the gallic acid. Nitric acid converts it into the malic and oxalic acids. Oxymuriatic acid produces peculiar changes on the gallic acid, but theſe have not been diſtinctly aſcertained ‡.

710 Of metallic oxides. 9. Although we have not yet treated of metallic ſubſtances, it may be neceſſary to anticipate a little, and mention the effects of gallic acid on metallic oxides. This indeed is its chief characteriſtic. On this account, it is much employed by chemiſts, to diſcover metallic ſubſtances, which are held in ſolution along with other bodies. Its effects on the metallic oxides are extremely various, and with different metals it affords different coloured precipitates. The more readily the metallic oxides give up their oxygen, the greater is the change produced by the gallic acid. On ſome metallic ſolutions it has no effect; ſuch are, ſolutions of platina, of zinc, of tin, of cobalt, and of manganeſe. The precipitates of the different metals produced by means of gallic acid, exhibit the following colours.

Gold,	Brown.
Silver,	Brown.
Mercury,	Orange-yellow.
Copper,	Brown.
Biſmuth,	Citron-yellow,
Iron,	Black.
Lead,	White.
Nickel,	Gray.
Antimony,	White.
Tellurium,	Yellow.
Uranium,	Chocolate.
Titanium,	Reddiſh-brown.
Chromium,	Brown.
Columbium,	Orange.

711 Compoſition. 10. The component parts of gallic acid are the ſame as thoſe of the other vegetable acids, but having a greater proportion of carbone; but theſe proportions have not been aſcertained.

712 Compounds. 11. The compounds which the gallic acid forms with alkalies, earths, and metallic oxides, are denominated *gallates*.

713 Affinities. 12. The affinities of this acid have not been aſcertained.

Sect. XXIV. *Of Benzoic Acid.*

714 History. 1. Benzoic acid is obtained from ſeveral plants, and particularly from the *ſtyrax benzoë*, a tree which grows in Sumatra; from the balſam of Peru and Tolu; from vanilla, and liquid amber. It alſo exiſts in the urine of children, and ſometimes in that of adults, but conſtantly in the urine of quadrupeds which live on graſs and hay, eſpecially in that of the horſe and cow. It is ſuſpected alſo that it exiſts in many of the graſſes, and that it is derived from them by means of the aliment to the urine of the animals in which it is found. Fourcroy and Vauquelin ſuſpect that it exiſts in the ſweet-ſcented graſs, (*anthoxanthum odoratum*, Lin.) which gives the fine flavour to hay *.

The firſt mention of benzoic acid is made by Blaiſe de Vigenere, who wrote about the commencement of the 17th century (R). He ſays, that he obtained, by diſtilling benzoin, an acid ſalt which cryſtallized in needles of a penetrating odour. It was then called *flowers of benzoin*, but at preſent *benzoic acid*.

715 Preparation. 2. To obtain this acid by the moſt common proceſs, put into an earthen pot a quantity of benzoin groſsly powdered. Cover the veſſel with a cone of paper, and apply a very gentle heat. The benzoic acid is ſublimed, and attaches itſelf to the ſides of the cone which may be renewed every two hours. Continue the proceſs till the acid ſublimed begins to be coloured by the oil which is diſengaged. By a proceſs propoſed by Geoffroy, the benzoin reduced to powder is digeſted in warm water, and this being filtered, yields on cooling needle-ſhaped cryſtals of benzoic acid; but the quantity obtained in this way is very ſmall, which led Scheele to adopt the following proceſs. He took

* *Connaiſs. Chim.* viii. p. 181.

† *Jour. Roy. Inſtit.* vol. i. p. 274.

‡ *Fourcroy Connaiſs. Chim.* tom. vii. p. 183.

* *Fourcroy Connaiſs. Chim.* tom. vii. p. 187.

(R) *Traité du feu et du ſel*, which was printed at Paris in 1608.

took 1 part of quicklime, to which were added 3 parts of water, and afterwards about 30 parts more, which is then to be gradually mixed with 4 parts of powdered benzoin. Heat the whole on a moderate fire for half an hour, continually agitating the mixture; then remove it from the fire, and let it remain at reſt for ſeveral hours. Decant the clear ſupernatant liquor, and add 8 parts more water to the reſiduum. Boil it for half an hour, and mix it with the former. Reduce the liquor by evaporation to two parts; add drop by drop to a ſlight exceſs, muriatic acid, which cauſes the benzoic acid to precipitate, by ſeparating it from the lime. Waſh the precipitate well on a filter; and to obtain it in cryſtals, diſſolve it in 5 or 6 times its own weight of boiling water, which on cooling yields cryſtals in the form of long compreſſed priſms.

716 Properties. 3. Pure benzoic acid is either in the form of a light powder, perceptibly cryſtallized, or in the form of very ſmall needles, of which it is extremely difficult to determine the ſhape. It is white and brilliant, and has ſome degree of ductility and elaſticity. It has an acrid, pungent, acidulous, and very bitter taſte. In the cold the odour is ſlight, but is aromatic, and this is ſufficient to characterize it. It reddens the tincture of turnſole, but has no effect on the ſyrup of violets. The ſpecific gravity of benzoic acid is 0.667.

717 Action of heat. 4. Expoſed to a moderate heat, it melts, forms a ſoft brown and ſpongy body which cools into a ſolid cruſt, exhibiting on the ſurface ſome appearance of cryſtallization. With a ſtronger heat it is ſublimed, and exhales a white acrid vapour, which affects the eyes. It burns when brought into contact with flame, and the whole is conſumed without any reſiduum. When it is diſtilled in cloſe veſſels, great part ſublimes unchanged, but part is decompoſed and yields a viſcid liquid, a conſiderable quantity of oil, and a much greater quantity of carbonated hydrogen gas than any other body of this nature. A very ſmall portion of coaly matter remains in the retort.

718 Of water. 5. It is not ſenſibly changed by expoſure to the air. It is ſcarcely ſoluble in cold water. Four hundred parts of boiling water diſſolve 20 parts of the acid, 19 of which are ſeparated on cooling.

719 Of acids. 6. Concentrated ſulphuric acid readily diſſolves this acid, and one part of the ſulphuric acid paſſes into the ſtate of ſulphurous acid. Benzoic acid may be ſeparated from this ſolution without having undergone any change, by adding water. The nitric acid diſſolves it in the ſame way, and it is alſo ſeparated by means of water. Guyton found, by diſtilling nitric acid on the concrete benzoic acid, that nitrous gas was diſengaged, only towards the end of the proceſs, and that the acid itſelf then ſublimed without alteration.

720 Compoſition. 7. As this acid yields by diſtillation oil and carbonated hydrogen gas, it is obvious that it muſt be compoſed of carbone and hydrogen, and probably alſo oxygen, although this latter has not been diſcovered in any experiments that have been made on this ſubſtance.

721 Compounds 8. Benzoic acid unites very readily with alkalies, earths, and metallic oxides, and the compounds which are thus formed are denominated *benzoates*.

722 Affinities. 9. The order of the affinities of benzoic acid is the following.

White oxide of arſenic,
Potaſh,
Soda,
Ammonia,
Barytes,
Lime,
Magneſia,
Alumina.

SECT. XXV. *Of Succinic Acid.*

723 Hiſtory. 1. Succinic acid, formerly called volatile ſalt of amber, was long regarded as an alkaline ſalt. It was not till towards the end of the 17th century, that its acid properties were diſcovered. As amber, the ſubſtance from which this acid is obtained, is found in conſiderable quantity under ſtrata of ſubſtances which contain pyrites, it was thought that this acid was formed by ſulphuric acid. This was the opinion of Hoffman and Neuman. Amber is found on the ſea-coaſt of different countries, eſpecially in the Pruſſian territory on the ſhores of the Baltic. The name of the acid is derived from *ſuccinum*, the Latin name for this ſubſtance.

724 Preparation. 2. Succinic acid may be obtained by the following proceſs. Introduce a quantity of amber in powder into a retort, and let it be covered with dry ſand. Adapt a receiver, and diſtill with a moderate heat in a ſand bath. There paſſes over firſt a liquid which is of a reddiſh colour, and afterwards a volatile acid ſalt, which cryſtallizes in ſmall, white, or yellowiſh needles in the neck of the retort; and if the diſtillation be continued, a white light oil ſucceeds, which becomes brown, thick, and viſcid. The acid which is obtained in this way is contaminated with the oil; and therefore to ſeparate this oil, it may be diſſolved in hot water, and paſſed through a filter on which has been placed a little cotton moiſtened with oil of amber, which retains the oil, and prevents it from paſſing through along with the acid. The acid may then be evaporated and cryſtallized. Guyton has obſerved, that the acid may be rendered quite pure, by diſtilling off it a ſufficient quantity of nitric acid, but with this precaution, that the heat employed is not ſtrong enough to ſublime the ſuccinic acid *.

725 Properties. 3. The acid thus obtained is in the form of white, ſhining, tranſparent cryſtals, which are foliated, triangular, and priſmatic. The taſte is acid, but not corroſive. It reddens the tincture of turnſole, but has no effect on the infuſion of violets.

726 Action of heat. 4. With the heat of a ſand bath, the cryſtals of ſuccinic acid firſt melt, and are then ſublimed and condenſed in the upper part of the veſſel. There is, however, a partial decompoſition, for there is a coaly matter left behind in the veſſel.

727 Of water. 5. At the temperature of 212°, two parts of water diſſolve one of this acid, which cryſtallizes on cooling. When the water is cold at the temperature of 50°, it requires 96 parts of water to diſſolve one of the acid.

728 Compoſition. 6. This acid like other vegetable acids, is compoſed of oxygen, hydrogen, and carbone; for when it is diſtilled in a retort with a ſtrong heat, carbonic acid gas, and carbonated hydrogen gas are evolved, and charcoal:

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* *Ann. de Chim.* tom. xxx. p. 162.

coal remains behind in the retort. The proportions of the component parts have not been aſcertained.

729 Compounds. 7. This acid enters into combination with alkalies, earths, and metallic oxides, and forms with them compounds which are denominated *ſuccinates*.

730 Affinities. 8. The affinities of this acid are in the following order:

Barytes,
Lime,
Potaſh,
Soda,
Ammonia,
Magneſia,
Alumina,
Metallic oxides.

Sect. XXVI. *Of Saclactic Acid.*

731 Hiſtory. 1. To this acid Fourcroy has given the name of *Mucous acid*, becauſe it is obtained from gum arabic and other mucilaginous ſubſtances; and it was formerly called *acid of ſugar-of-milk*. This latter name it received from Scheele, who diſcovered it in the year 1780, while he was employed in making experiments on the ſugar of milk, in order to obtain from it oxalic acid, which he procured from ſugar.

732 Preparation. 2. This acid may be obtained by the following proceſs. To 1 part of gum arabic, or other mucilaginous ſubſtance, add 2 parts of nitric acid in a retort, and apply a gentle heat. There is at firſt diſengaged a little nitrous gas and carbonic acid gas, after which let the mixture cool. There is then precipitated a white powder which is ſlightly acid. This powder is the ſaclactic acid.

733 Properties. 3. Thus obtained, ſaclactic acid is in the form of a white powder, a little gritty, and with a weak acid taſte.

734 Action of heat. 4. It is readily decompoſed by heat, and yields an acid liquor which cryſtallizes by reſt in the ſhape of needles, a ſmall quantity of an acrid cauſtic oil, of a blood red colour, carbonic acid gas, and carbonated hydrogen gas; and there is left behind a conſiderable quantity of coaly matter. It is partly ſublimed in needles or brown plates, with an odour ſimilar to that of benzoic acid [*].

735 Of water. 5. Saclactic acid in the ſtate of powder is not very ſoluble in water. Cold water does not take up more than 200 or 300 parts of its weight; boiling water does not take up above one half more. On cooling, the acid is depoſited in brilliant ſcales, which become white in the air. The ſolution has an acid taſte. It reddens the tincture of turnſole. Its ſpecific gravity at the temperature of 59° is 1.0015 [†].

736 Compounds. 6. This acid enters into combination with earths, alkalies, and metallic oxides; and the ſalts which it forms are known by the name of *ſaccolates*.

737 Affinities. 7. The order of its affinities, according to Bergman, is the following.

Lime,
Barytes,
Magneſia,
Potaſh,
Soda,
Ammonia,
Alumina,
Metallic oxides.

Sect. XXVII. *Of Camphoric Acid.*

738 Hiſtory. 1. This acid is obtained, as the name imports, from *camphor*, a concrete ſubſtance procured from a ſpecies of laurel (*Laurus camphora*, Lin.) which is a native of the Eaſt Indies.

739 Preparation. 2. Camphoric acid was firſt obtained by Koſegarten, by diſtilling nitric acid 8 times ſucceſſively off camphor. This experiment was repeated by Bouillon Lagrange with the ſame reſult. He introduced into a glaſs retort, 1 part of camphor, and he poured over it 4 parts of nitric acid. A receiver was adapted to the retort, and the joinings were well luted. The retort was placed on a ſand-bath, and a gradual heat was applied. A great deal of nitrous gas and carbonic acid gas was diſengaged. One part of the camphor is ſublimed, and another part ſeizes on the oxygen of the nitric acid. The ſame proceſs muſt be repeated till the whole of the camphor is acidified, which is known by its cryſtallizing when the liquor cools which remains in the retort. Theſe cryſtals are camphoric acid. To purify it, it muſt be diſſolved in diſtilled warm water, and the liquor is then to be filtered and evaporated to nearly half its volume, or till a thin pellicle is formed on it. When it cools, cryſtals of pure camphoric acid will be obtained.

740 Properties. 3. Camphoric acid has a ſlightly acid, bitter taſte. It reddens the tincture of turnſole. The cryſtals reſemble, when, in a maſs, thoſe of the muriate of ammonia. Expoſed to the air the maſs effloreſces.

741 Action of water. 4. Cold water diſſolves this acid with great difficulty. An ounce of water at the temperature of between 50° and 60°, cannot diſſolve more than 6 grs. while water at the boiling temperature will hold in ſolution eight times that quantity.

742 Of heat. 5. When this acid is put upon burning coals, it exhales a denſe, aromatic vapour; with a leſs degree of heat, it melts, and is ſublimed. When put into a heated porcelain tube, and if a ſtream of oxygen gas be paſſed through it, the acid remains unchanged, but it is ſublimed from the ſides of the tube. When diſtilled alone, it firſt melts and then ſublimes. This ſublimation produces ſome change in its properties. It no longer reddens the tincture of turnſole, and acquires a ſtrong aromatic odour, and a leſs pungent taſte; becomes inſoluble in water, and in the ſulphuric and muriatic acids. The nitric acid heated, makes it yellow, and diſſolves it [*].

Compounds. 6. Camphoric acid enters into combination with the alkalies, earths, and metallic oxides, and the compounds thus formed are denominated *camphorates*.

744 Affinities. 7. The affinities of this acid are the following [†].

Lime,
Potaſh,
Soda,
Barytes,
Ammonia,
Alumina,
Magneſia.

Sect. XXVIII. *Of Suberic Acid.*

745 Hiſtory. 1. This acid is obtained from cork, a well-known ſubſtance, which is the bark of a tree (the *quercus ſuber*

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[*] Fourcroy Connaiſs. Chim. tom. vii. p. 147.

[†] Encyc. Method. i. p. 290.

[*] Ann de Chim. tom. xxiii. p. 170.

[†] Ibid. xxvii. p. 40.

Lin. or cork-tree.) From the Latin name of this ſubſtance, *ſuber*, the name of the acid is derived, and hence it is called *ſuberic acid*. The acid which is obtained from cork, by treating it with nitric acid, was ſuppoſed to be the oxalic acid, on account of poſſeſſing ſome common properties, and particularly that of forming with lime an inſoluble ſalt. But the experiments of Bouillon Lagrange have ſhewn, that this is a peculiar acid.

746 Preparation. 2. This acid is obtained by the following proceſs. Take a quantity of clean cork, grated down. Introduce it into a retort, and pour on it ſix times its weight of nitric acid; the acid ought not to be too concentrated. It is then to be diſtilled with a moderate heat. The cork ſwells up and becomes yellow, and there is diſengaged a quantity of red vapours; and as the diſtillation goes on, the cork is diſſolved, and ſwims on the ſurface like foam. If this ſcum is not formed, the cork has not been acted upon by the acid. In this caſe when the diſtillation begins to ſtop, return into the retort the acid which had paſſed over into the receiver, and diſtil as long as any red vapours appear, and then immediately remove the retort from the ſand bath, and pour out the contents while yet hot into a glaſs or porcelain veſſel; put it upon a ſand bath and apply a gentle heat, ſtirring it conſtantly with a glaſs rod. The matter gradually thickens, and as ſoon as white vapours are diſengaged, which excite a tickling in the throat, it is to be removed from the ſand bath, and conſtantly ſtirred till the maſs is nearly cold. In this way a ſubſtance is obtained of the conſiſtence of honey, of an orange-yellow colour, of a ſharp penetrating odour while it is warm, but which gives out a peculiar aromatic ſmell when it is cold.

To procure the acid which is contained in this ſubſtance, put it into a matraſs, and pour upon it double its weight of diſtilled water. Apply heat till the maſs becomes liquid, and ſeparate by filtration that part which is inſoluble in water. The liquor which is obtained is of a clear amber colour, and of a peculiar odour. The filtered liquor on cooling becomes muddy, is covered with a thin pellicle, and depoſits a powdery ſediment. The precipitate is to be ſeparated from the liquid by filtration, and it is to be dried with a gentle heat. This precipitate is the ſuberic acid. The remaining liquor is then to be evaporated to dryneſs with a moderate heat, to obtain the whole of the acid which it holds in ſolution.

The acid which is prepared by this proceſs is a little coloured, and may be purified, either by ſaturating the ſuberic acid with potaſh, and precipitating with an acid, or by boiling it with charcoal powder.

747 Properties. 3. Suberic acid is in the ſolid form, but it is not cryſtallized. When it is obtained by precipitation, it is in the ſtate of a powder, and by evaporation it is in the form of thin irregular pellicles.

4. It has a ſlightly bitter and acid taſte. Diſſolved in a ſmall quantity of boiling water, it tickles the throat, and excites coughing. It reddens vegetable blues.

748 Action of light. 5. Expoſed to the light, it becomes brown after a certain time; but this effect is more ſpeedily produced when it is expoſed to the ſun's rays. 749 Of heat. Heated in a matraſs, the ſuberic acid is ſublimed, and the glaſs remains marked with zones of different colours. If the ſublimation be ſtopped in time, the acid is obtained on the ſides of the veſſel, in ſmall points formed of concentric circles. When expoſed to the heat of the blowpipe on a ſpoon of platina, it firſt melts, then falls down into powder, and at laſt is totally diſſipated by ſublimation.

750 Of acids. 6. It undergoes no change from the action of oxygen gas. The action of the acids on ſuberic acid is very weak. The ſolution is not complete, eſpecially when it is impure.

751 Of water. 7. Water at the temperature of 60° or 70° diſſolves the concrete acid only in the proportion of 10 grs. to the ounce. When the acid is very pure, the water will not diſſolve more than 4 grs. Boiling water diſſolves half its weight; but as the liquor cools, it becomes muddy, and the acid is depoſited *.

752 Compounds. 8. This acid combines with the alkalies, earths, and metallic oxides, and forms with them compounds which are known by the name of *ſuberates*.

753 Affinities. 9. The order of its affinities is the following †.

Barytes,
Potaſh,
Soda,
Lime,
Ammonia,
Magneſia,
Alumina,
Metallic oxides.

SECT. XXIX. *Of MELLITIC ACID.*

754 Diſcovery. 1. This acid is procured from a mineral ſubſtance which was diſcovered about the year 1790. Werner gave it the name of *honigſtein*, (honeyſtone) from its colour. By other mineralogiſts it has been denominated mellite, from the Latin name of honey, and hence the acid which it affords has been called *mellitic* acid. The mineral from which this acid is obtained ſeems to be of vegetable origin. It is found in ſmall cryſtals among the layers of wood coal at Arten in Thuringia. In the firſt analyſis to which this mineral was ſubjected no new acid was detected. But in the year 1799 the acute and accurate Klaproth examined its nature and component parts, and found that it is a compound of a peculiar acid and alumina. His experiments have been ſince repeated by Vauquelin, and the reſult of his analyſis has been fully confirmed.

755 Proceſs for obtaining. 2. It is procured from mellite by the following proceſs. The mineral is to be reduced to powder, and boiled with about 72 times its weight of water. The alumina is precipitated in the form of flakes, and the acid combines with the water. By filtration and evaporation, cryſtals are depoſited, which are the cryſtals of mellitic acid.

756 Properties. 3. This acid cryſtallizes in the form of fine needles, or in ſmall ſhort priſms with ſhining faces. They are conſiderably hard. It has a ſlightly acid taſte, accompanied with ſome degree of bitterneſs.

757 Action of water. 4. This acid has very little ſolubility in water, but it has not been aſcertained to what degree; or what proportion of water it requires for its ſolution.

758 Of heat. 5. A ſmall quantity of this acid expoſed to the flame of the blow-pipe, at firſt gave out ſparks like nitre; and then ſwelled up, and left a matter which

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* Annal. de Chim. tom. xxiii. p. 42.

† Ibid. p 57.

penetrated the charcoal. Heated in a crucible of platina, it ſwells up at firſt, is then charred, without the production of any oily vapour, and leaves behind a light coaly alkaline matter *.

759 Of acids. 6. When the nitric acid is added to this acid, is produces no other change than giving it a yellowiſh colour. It has not yet converted it into any of the vegetable acids to which it is nearly allied in its properties and conſtituent parts.

760 Compoſition. 7. According to Klaproth's analyſis the mineral from which the acid is obtained conſiſts of

46	mellitic acid,
16	alumina,
38	water.
100	

When it was diſtilled in a retort the acid was completely decompoſed; and the products obtained by Klaproth in this way from 100 grains of mellite were the following:

54	cubic inches of carbonic acid gas,
13	hydrogen gas,
38	grs. of acidulous water,
1	aromatic oil,
9	charcoal,
16	alumina.

The conſtituent parts of mellitic acid are obviouſly carbone, hydrogen, and oxygen. But the proportions have not been aſcertained.

761 Compounds. 8. Mellitic acid enters into combination with the earths, alkalies, and metallic oxides, and forms compounds with them which are called *mellates*.

SECT. XXX. *Of Lactic Acid.*

762 Diſcovery. 1. In inveſtigating the changes which ſpontaneouſly take place in milk, the celebrated Scheele diſcovered that it contains a peculiar acid. To this has been given the name of *lactic acid*. The formation of this acid depends on the change of the ſugar of milk or of the ſaccharine mucous matter; for after the acid is once well formed, when the ſerous part of the milk being very ſour reddens vegetable blues, no more is obtained by evaporation and cryſtallization.

763 Preparation. 2. Scheele did not ſucceed in ſeparating the acid from the ſerous part of the milk by diſtillation. He therefore contrived the following proceſs. He evaporated a quantity of ſour whey to $\frac{1}{8}$th of its bulk, and then filtered it to ſeparate the whole of the coagulated cheeſy matter. He then added lime-water to precipitate the phoſphate of lime, and diluted the liquid with three times its weight of pure water. He then precipitated the exceſs of lime by means of the oxalic acid, adding no more of the latter than what is neceſſary. He evaporated the ſolution to the conſiſtency of honey, poured on a quantity of alcohol which ſeparates the portion of ſugar of milk and of other extraneous matter, and diſſolves the lactic acid; and diſtilled the clear filtered liquor till the whole of the alcohol employed be driven off: what remains in the retort is the lactic acid.

764 Properties. 3. This acid is never cryſtallized; but always appears in the form of a viſcid mucilaginous ſubſtance. It has a ſtrong ſharp taſte, which is far from being agreeable. It reddens the tincture of turnſole, and gives a reddiſh violet ſhade to the ſyrup of violets.

765 Compoſition. 4. When it is diſtilled in a retort it yields an empyreumatic acid which is very ſtrong and analogous to the tartaric, very little oil, carbonic acid gas, and carbonated hydrogen gas, and a ſmall quantity of coaly matter which adheres to the glaſs. This ſhews what are the conſtituent parts of this acid, but the proportions of theſe have not been determined.

766 Compounds. 5. The compounds with alkalies, earths, and metallic oxides which are formed with the lactic acid, are denominated *lactates*.

767 Affinities. 6. The affinities of this acid are in the following order.

Barytes,
Potaſh,
Soda,
Strontites,
Lime,
Ammonia,
Magneſia,
Metallic oxides,
Glucina,
Alumina,
Zirconia.

SECT. XXXI. *Of Laccic Acid.*

768 Hiſtory, 1. The ſubſtance from which this acid is obtained, is collected in the neighbourhood of Madras. It was firſt deſcribed by Dr Anderſon, who ſays that neſts of inſects reſembling ſmall cowry ſhells were brought to him from the woods by the natives, who eat them with avidity. Theſe ſuppoſed neſts he ſhortly afterwards diſcovered to be the coverings of the females of an undeſcribed ſpecies of coccus; and having noticed in the Abbé Groſier's account of China, that the Chineſe collect a kind of wax, much eſteemed by them, under the name of *péla* from a coccus depoſited for the purpoſe of breeding on certain ſhrubs, and managed exactly in the ſame manner as the Mexicans manage the cochineal inſects, he followed the ſame proceſs with his new inſects, and found means to propagate them with great facility on trees and ſhrubs in the neighbourhood.

769 and nature of the ſubſtances from which it is obtained. This ſubſtance, which he called white lac, was found on examination to have a conſiderable reſemblance to bees wax. Dr Anderſon ſuppoſes, that the animal which ſecretes it provides itſelf, by ſome means or other, with a ſmall quantity of honey, reſembling that produced by our bees. The ſweetneſs of it tempted the children who were employed to collect it, to eat ſo much of it as very much to diminiſh his crop. A ſmall quantity of this matter was ſent to Europe in 1789. It was examined by Dr Pearſon, who publiſhed an account of his analyſis in the Philoſophical Tranſactions for 1794, from which we have extracted the information which we now lay before our readers.

A piece of white lac, which weighs from three to fifteen grains, is ſuppoſed to be produced by each inſect. Theſe pieces are about the ſize of a pea, of a gray colour, opaque and roundiſh, but with a flat ſide, by which they adhere to the bark. In its dry ſtate, white lac is ſoft and tough, and has a ſaltiſh and bitteriſh taſte. A watery liquid, which has a ſlight ſalt taſte, oozes out on preſſing a piece of this ſubſtance. White lac has no ſmell, unleſs it be preſſed or rubbed, when it becomes ſoft, and then it emits a peculiar odour. When it is gathered from the tree, the pieces of lac are lighter than bees-wax; but after being melted and purified, it ſinks in water. It melts in alcohol and in water at the temperature of 145°, and very readily in boiling water.

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* Ann. de Chim. vol xxxvi. 210.

770 Preparation. 2. Dr Pearſon expoſed 2000 grains of white lac to ſuch a degree of heat as was ſufficient to melt them. They became ſoft and fluid, and there oozed out 550 grains of a reddiſh watery liquid, which emitted the ſmell of newly baked bread. The liquid was filtered and purified from extraneous matter. This liquid is *laccic acid*.

771 Properties. 3. It has a ſlightly ſaltiſh taſte, with ſome degree of bitterneſs. It ſmells when heated like newly baked hot bread. It reddens the tincture of turnſole. Its ſpecific gravity, at the temperature of 60° is 1.025. When this liquid remains for ſome time at reſt, it becomes turbid, and depoſits a ſediment. When it is evaporated, it becomes more turbid; and allowed to remain at reſt, it affords ſmall needle-like cryſtals in mucilaginous matter.

772 Action of heat. 4. Two hundred and fifty grains of this liquid were expoſed to heat in a ſmall retort. As the liquor grew warm, mucilage-like clouds appeared, but when it grew hot, they diſappeared. At the temperature of 200° it diſtilled over very faſt. On diſtillation to dryneſs, a ſmall quantity of extractive matter remained. The diſtilled liquid was tranſparent and yellowiſh, and while hot, had the ſmell of newly baked bread. Paper ſtained with turnſole which had been put into the receiver, was not reddened. One hundred grains of yellowiſh tranſparent liquid being evaporated till it became turbid, afforded in the courſe of a night, acicular cryſtals which had a bitteriſh taſte. Under a lens they appeared in a group, ſomewhat reſembling the umbel of parſley. One hundred grains of yellowiſh tranſparent liquid being evaporated in a low temperature to dryneſs, a blackiſh matter remained behind, which did not entirely diſappear when expoſed to pretty ſtrong heat; but on heating oxalic acid to a leſs degree, it evaporated and left no trace behind.

From theſe properties, and from its peculiar action with alkaline, earthy, and metallic ſalts, Dr Pearſon concludes, that this acid is different from any of the acids already known.

773 Compoſition. 5. The experiments which have been made on white lac, and on the acid obtained from it, ſhow that it is cloſely allied to the vegetable acids. Its component parts, therefore, probably are, carbone, hydrogen, and oxygen; but experiments are ſtill wanting fully to aſcertain its nature and properties *.

Sect. XXXII. *Of Pruſſic Acid.*

774 Hiſtory. 1. This is one of the moſt important acids, both to the chemiſt, and to the manufacturer. It has been alleged that the ancients were acquainted with Pruſſian blue, which they employed in painting; but Landriani has ſhown, in his diſſertation on this ſubſtance, from the evidence of Theophraſtus and Pliny, and from the analyſis of an Egyptian mummy, that the ancients employed ultramarine blue and the ſmalt or azure of cobalt; and that Pruſſian blue which is readily acted on by the ſubſtances to which it muſt have been expoſed in theſe countries, could not reſiſt their influence for ſo many ages, and retain the beautiful colours which are admired in the paintings of Herculaneum.

775 The diſcovery. 2. Stahl relates, in his 300 experiments, that the diſcovery of Pruſſian blue was owing to an accident. About the beginning of the 18th century, Dieſbach, a chemiſt of Berlin, wiſhing to precipitate a decoction of cochineal with an alkali, borrowed from Dippel ſome potaſh, on which he had diſtilled ſeveral times his animal oil; but as there was ſome ſulphate of iron in the decoction of cochineal, the liquor inſtantly exhibited a beautiful blue in place of a red precipitate. Reflecting on the circumſtances which had taken place, he found that it was eaſy to produce at pleaſure the ſame ſubſtance, which afterwards became an object of commerce. It obtained the name of *Pruſſian blue*, from the place where it was diſcovered.

776 Firſt announced. 3. This diſcovery was announced in the Memoirs of the Academy of Berlin, for the year 1710; but the proceſs by which it was obtained was kept ſecret, that thoſe who were in poſſeſſion of it might derive the whole advantage from the manufacture. It was publiſhed for the firſt time by Woodward in the Philoſophical Tranſactions for the year 1724, who declared, that it had been ſent to him from Germany, by one of his friends. This is all that is known of the manner by which this proceſs was made public. It is not certain whether it came originally from the firſt inventors, or whether it be owing to the reſearches of ſome chemiſt.

777 Proceſs. 4. The method which is deſcribed by Woodward ſucceeds very well. It is by preparing an extemporaneous alkali, by detonating four ounces of nitre, and an equal quantity of tartar; then to add four ounces of bullock's blood, well dried, and to calcine the whole with a moderate heat, till the blood be reduced to a coal, or emit no ſmoke capable of blackening any white body that is expoſed to it. Towards the end of the proceſs the firſt is to be increaſed, till the crucible which contains the materials ſhall be moderately red. Throw the red-hot matter into water, and boil it for half an hour; and having poured off the firſt water, add another quantity, and boil it again. Repeat this operation till the laſt water comes off inſipid, then add all the quantities of water together, and evaporate to the quantity of two pints. To this liquid the Germans have given the name of *blood ley*. By others it has been denominated *phlogiſticated alkaline ley*.

5. A ſolution of 2 ounces of ſulphate of iron, and 8 ounces of alum, in two pints of boiling water, is to be mixed with the former ſolution while both are hot. A great efferveſcence takes place; the liquor becomes muddy, aſſumes a greeniſh colour, inclining more or leſs to blue; and a precipitate is formed of the ſame colour. Separate this precipitate, and to heighten the colour, pour upon it carefully muriatic acid till it no longer increaſes the intenſity of the blue colour; then waſh it with water, and dry it ſlowly.

6. Such was the proceſs by which Pruſſian blue was obtained, before the theory was diſcovered, to account for the different changes and effects which it preſented.

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* *Phil. Tranſ.* 1794. p. 383.

778 Nature of it inveſtigated by ſeveral chemiſts.

The ſame year in which Woodward publiſhed an account of the proceſs, Brown inſtituted a ſet of experiments, to diſcover the nature of this ſubſtance, and the circumſtances which attended its formation. He found that fleſh, as well as bullock's blood, poſſeſſed a ſimilar property. He thought that Pruſſian blue was the bituminous part of iron, developed by the alkaline ley, and fixed in the aluminous earth. Geoffroy adopted the ſame explanation. He found that, in the animal kingdom, oils, wool, hartſhorn, ſponge, had the ſame effect as blood with the alkali, in precipitating iron of a blue colour; and that ſome vegetable charcoal treated with the alkali, in ſome meaſure communicated to it a ſimilar property. Neuman diſcovered that the animal empyreumatic oils might be employed for the ſame purpoſe. The abbé Menon was of opinion, that the colour of iron is blue; but that this colour, uſually diſguiſed by ſome ſaline matter, reappears, when it is ſeparated by the phlogiſticated alkaline ley, and thus Pruſſian blue was only iron precipitated in its natural ſtate. The aluminous earth, he ſaw, ſerved only to diminiſh the intenſity of the colour, and to give it a more agreeable ſhade.

779 By Macquer.

7. It is to the celebrated Macquer that we are indebted for the firſt correct views in developing the theory of this proceſs. He obſerved, 1. That pure alkalies precipitated iron from its ſolutions of a yellow colour. 2. That this precipitate is ſoluble in acids. 3. That the blue fecula obtained from the blue phlogiſticated ley after the addition of muriatic acid, was not acted on by acids. He therefore concluded that the firſt green precipitate was not a homogeneous ſubſtance, but a mixture of two precipitates, the one yellow and the other blue; and that it was ſufficient to remove the firſt by any acid, to give to the ſecond its full intenſity of colour. Hence he ſuppoſed, that the acid of the alum employed in this proceſs was uſeful in ſaturating, in a great meaſure, the pure alkaline portion of the ley, and diminiſhing proportionally the yellow precipitate of iron. Having found that it was impoſſible to ſaturate the alkali with a colouring matter by means of calcination; and, having diſcovered that the pure alkali deprived iron (which was converted into Pruſſian blue) of its characteriſtic properties; and finally, having aſcertained that the alkali which was employed in the proceſs became exactly ſimilar to that which was calcined with combuſtible matters, to prepare it for the precipitation of iron of a blue colour, and that its alkaline properties diſappeared as it was more or leſs ſaturated with the colouring matter, he attempted to ſaturate it fully. He therefore ſaturated an alkali ſo completely with the colouring matter, that it underwent no change by boiling, and exhibited none of its alkaline properties by chemical teſts. By this diſcovery we are now in poſſeſſion of this valuable ſubſtance which had been hitherto known under the name of the *ſaturated ley of the colouring matter of Pruſſian blue.*

In the courſe of his experiments Macquer found, that the ſaturated ley could not be decompoſed by ſulphuric acid, or by the ſolution of alum; but, on the contrary, that every metallic ſubſtance diſſolved in an acid, ſeparated the phlogiſtic matter from all the fixed and volatile alkalies. Hence he concluded, that in the proceſs of the formation of Pruſſian blue, it is neceſſary that the affinity of the iron ſhould combine with that of the acid with the alkali, to form a ſum of affinities capable of effecting the ſeparation. This luminous explanation of ſo ſtriking a proceſs, has not a little contributed to eſtabliſh the theory of compound affinities.

780 and others.

8. After the publication of Macquer's diſſertation, almoſt all chemiſts were occupied in reſearches into the nature of Pruſſian blue, either to diſcover the nature of its principles, or to improve the proceſs for preparing the colouring matter: but they were chiefly occupied in examining thoſe bodies which were capable of phlogiſticating the alkali, as it was called; and this property was found to exiſt in a great number of ſubſtances. Till the year 1775, no change or modification was propoſed on the theory of Macquer.

781 By Bergman.

9. About this time the celebrated Bergman, in his diſſertation on elective attractions, threw new light on this ſubject of inveſtigation, by conſidering the colouring matter of Pruſſian blue as a diſtinct acid, and poſſeſſed of peculiar attractions. According to Sage, the alkali which precipitated Pruſſian blue was nothing but an alkali ſaturated with phoſphoric acid; but Lavoiſier juſtly remarked, that, according to this theory, the ſalt formed of phoſphoric acid and an alkali ought to precipitate a ſolution of ſulphate of iron of a blue colour, which was not the caſe.

Many chemiſts examined the nature of this ſubſtance by means of heat, and among others Delius and Scopoli, Deveux and Parmentier, Bergman and Erxleben, ſubjected it to diſtillation, the product of which was a quantity of ammonia. By others an oil was obtained in this proceſs, and ſometimes a peculiar acid, which had the properties of ſulphuric acid. The difference of theſe reſults probably aroſe from the different ſtates of purity of the Pruſſian blue which was employed in the experiment.

782 By Fontana.

Fontana diſcovered that the ſulphuric acid diſtilled on Pruſſian blue paſſed to the ſtate of ſulphurous acid, and that the colouring matter produced detonation with nitre. Landriani found that it yielded by diſtillation, beſides ammonia, a ſmall portion of liquid perceptibly acid, and ſome oil, and a great quantity of elaſtic fluids, which conſiſted of azotic and hydrogen gaſes, the latter burning with a blue flame, and detonating ſtrongly with oxygen gas.

783 By Scheele

10. But the moſt important ſtep in the progreſs of the diſcovery of the nature and properties of this ſingular ſubſtance, was made by Scheele, an account of which he publiſhed in two diſſertations in the Stockholm tranſactions for 1782 and 1783. He began by examining the blood-ley, and he found by expoſing it for ſome time to the air, that it loſt the property of precipitating iron of a blue colour, and the precipitate which it then yields is ſoluble in acids. To diſcover what change had taken place on the air, he put ſome of the ley freſh prepared into a large glaſs globe cloſe ſhut up, and he found ſome time after, that neither the air nor the ley had undergone any change. He concluded, therefore, that the colouring matter was not pure phlogiſton. He ſuſpected that carbonic acid might have ſome effect in changing the nature of the alkali when expoſed to the open air. He filled a globe with carbonic acid gas, and having introduced a quantity of Pruſſian alkali, he kept it cloſe ſhut

784 He examines the ley.

785 Effect of carbonic acid.

up

786 Iron fixes the colouring principle.

up for 24 hours, after which, on examining the alkali, it gave a precipitate which was ſoluble in acids; the change, then, muſt have been occaſioned by the carbonic acid gas. He repeated this experiment by adding to the colouring matter a ſmall quantity of ſulphate of iron. This matter was not changed by the action of the carbonic acid gas. The ſame reſult was obſerved when he boiled the colouring matter in an oxide of iron precipitated by an alkali. It ſuffered no change in the carbonic acid gas, but precipitated the iron as before. The iron then has the property of fixing the colouring principle, of defending it againſt the action of carbonic acid gas; and hence it happens that the neutral colouring ſalt formed with an alkali boiled on Pruſſian blue, does not ſo eaſily loſe its properties. But if the colouring ley be digeſted on an oxide of iron, as that which is obtained from the ſulphate of iron boiled in nitric acid, and afterwards precipitated by an alkali, no effect is produced. By this digeſtion the action of the gas is not prevented, and if the ſulphate of iron be added, even with an exceſs of acid there is no longer a production of Pruſſian blue.

787 It is diſengaged by acids.

To diſcover what happened to the colouring principle, when it was charged with carbonic acid gas, Scheele introduced into a globe filled with this gas, ſome of the Pruſſian alkali, and ſuſpended in it a bit of paper, previouſly dipped in a ſolution of ſulphate of iron, and on which he had let fall two drops of alkaline liquor to precipitate the iron. The paper was removed at the end of two hours, and, with the addition of a little muriatic acid, was covered with a fine blue colour. The ſame experiments repeated with alkali ſaturated with exceſs of ſulphuric acid, gave the ſame reſult; that is to ſay, the paper charged with oxide of iron and ſuſpended as above, became of a blue colour on adding muriatic acid. Hence it follows, that the colouring principle is diſengaged by acids, without decompoſition, for it ſtill has the property of being fixed with oxide of iron with which it comes in contact. Thus he found that the colouring matter might be ſeparated from the ſubſtances with which it was generally in combination, and without undergoing decompoſition.

788 To ſeparate the colouring matter.

11. To obtain it, therefore, in a ſeparate ſtate, he contrived the following proceſs. He put into a glaſs veſſel two parts of Pruſſian blue reduced to powder, one part of red oxide of mercury, and ſix parts of water. He boiled the mixture for ſome minutes, continually ſtirring it. It then aſſumes a yellowiſh green colour. He put the whole on a filter, and poured upon the reſiduum two parts more of boiling water, to waſh it completely. This liquid is a ſolution of mercury combined with the colouring matter, which has the metallic taſte, and is neither precipitated by acids nor alkalies. Pour this liquid into a glaſs veſſel upon one half part of clean iron filings, and a ſmaller quantity of concentrated ſulphuric acid. Shake the mixture well for ſome minutes, when it becomes black by the reduction of the mercury. The liquid then loſes its metallic taſte, and gives out the odour which is peculiar to the colouring matter. Having allowed it to remain at reſt for ſome time, it is poured off, put into a retort to which a receiver is adapted, and diſtilled with a gentle heat. One-fourth part of the liquid only ſhould be allowed to paſs over, for the colouring matter is much more volatile than water, and conſequently riſes firſt. The liquid in the receiver is commonly mixed with a little ſulphuric acid, from which it may be ſeparated by diſtilling again off a little powdered chalk, which takes up the ſulphuric acid. The liquid then paſſes over in a ſtate of purity; and this liquid is *pruſſic acid*.

789 Pruſſic acid obtained.

790 Nature of this proceſs.

12. In this proceſs the oxide of mercury which was mixed with the colouring matter, takes it from the iron with which it is combined in the ſtate of Pruſſian blue, and is then a cryſtallizable pruſſiate of mercury. The iron which is added in the metallic ſtate, reduces the oxide of mercury, and at the moment it combines with the ſulphuric acid, which has alſo been added, the heat applied ſublimes the pruſſic acid which has been diſengaged from the mercury, which is now reduced to the metallic ſtate. The pruſſic acid thus obtained, partly in the liquid, and partly in the gaſeous ſtate, combined with alkalies, produces the ſame effects as the blood ley, and the colourleſs Pruſſian blue.

791 Compoſition.

13. Having obtained the pruſſic acid in a ſeparate ſtate, it was his next object to diſcover its component parts. He had obſerved in the proceſs for procuring it, that the air in the receiver was inflammable; and in decompoſing the pruſſiates, he obtained ammonia and carbonic acid, and found that ſome metals were reduced by diſtillation with the metallic pruſſiates. He concluded from this, that pruſſic acid was compoſed of ammonia and oil, and he endeavoured to prove this by the teſt of experiment; but he ſoon found that he could not ſucceed in forming the colouring compound, by combining ammonia and the different oils heated together. Seeing that water was an obſtacle to the formation of the pruſſic acid, he conducted his experiments in a different way, by combining the ammonia with the dry combuſtible principle, which he ſuppoſed exiſted in oils, and with the carbonic acid, equally in the dry ſtate. He ſaw that charcoal alone, ſtrongly heated with fixed alkalies, gave them the property of colouring iron blue. Having heated theſe two ſubſtances in crucibles, he added to the one muriate of ammonia, at the moment when the firſt mixture had acquired a white heat, and he continued the heat till no more vapour was diſengaged. This proceſs furniſhed him with a pure Pruſſian alkali, whilſt the combination of the alkali and the charcoal, without the addition of the muriate of ammonia, afforded none.

792 Berthollet's experiments.

14. Such was the ſtate of our knowledge with regard to the colouring matter of Pruſſian blue, when Berthollet, at the end of 1787, communicated to the Academy of Sciences, the reſult of his inveſtigations into the nature and properties of this ſubſtance. He repeated the experiments of Scheele, improved and extended his views, and confirmed his concluſions. The reſult of his reſearches on this ſubſtance was cloſely connected with the light which he had thrown on the nature and compoſition of ammonia ſome years before. He proved that the alkaline pruſſiate is a triple ſalt, which is compoſed of pruſſic acid, the alkali and iron; that when it is evaporated and re-diſſolved, it affords cryſtals in the form of octahedrons; and mixed with ſulphuric acid, and expoſed to the ſun, there is precipitated Pruſſian blue, which does not happen

in the dark. After theſe preliminary experiments, he proceeded to the examination of pruſſic acid, by the action of oxymuriatic acid. This acid, in proportion as it is diſſolved in the pruſſic acid, is deprived of its oxygen, and is converted into the ſtate of muriatic acid. The pruſſic acid becomes more odorous and volatile, and leſs ſuſceptible of combination with the alkalies, precipitating iron from its ſolutions, of a green colour. This green precipitate recovers its blue colour when expoſed to the light, by contact with ſulphurous acid, by iron. It is the oxy-pruſſic acid. When the oxymuriatic acid is ſtill continued to be added in the ſtate of gas, and is expoſed to the light, the new acid ſeparates from the water, and is precipitated to the bottom in the form of an aromatic oil, which is converted by heat to an inſoluble vapour, which is no longer capable of combining with iron. Thus ſuperoxygenated, this acid can no longer return to its original ſtate. It is totally different in its properties.

793
Oxy-pruſſic acid.

When the oxypruſſiate of iron, which is prepared by treating Pruſſian blue with the oxymuriatic acid, and which is diſtinguiſhed by its green colour, is deprived of its acid, by being brought into contact with a cauſtic fixed alkali, it is inſtantly decompoſed, and is converted into carbonate of ammonia.

15. Scheele and Bergman were of opinion, that pruſſic acid contained ammonia ready formed. Berthollet, however, concludes from his experiments, that it only contains the elements, namely, the azote and hydrogen, both in combination with carbone; and thus he conſiders pruſſic acid to be a triple compound of hydrogen, carbone and azote, but he has not been able to aſcertain the proportions. He thinks, however, that the hydrogen and azote come near to the proportions which exiſt in ammonia *.

794
Pruſſic acid a triple compound.

16. In ſome experiments by M. Clouet, on the colouring matter of Pruſſian blue, he attempted to combine the elements of ammonia with charcoal, with the view of producing pruſſic acid; but in whatever proportion he employed them, no colouring matter was obtained. He therefore concluded, that it was neceſſary to combine directly the ammonia with the charcoal, for the production of this ſubſtance. He took 2½ parts of quicklime in powder, and mixed them with one part of ſal ammoniac dried, and alſo in the ſtate of powder. He put the mixture into a porcelain retort, which he placed upon a ſand-bath. To the beak of the retort was adapted a porcelain tube filled with dry powdered charcoal. The porcelain tube paſſed acroſs a furnace, in which it might be ſtrongly heated. It was then made red hot, and heat being afterwards applied to the retort, the ammonia was diſengaged in the ſtate of gas, which paſſed through the red hot porcelain tube containing the charcoal. The product was received in proper veſſels, and when examined, was found to be the colouring matter of Pruſſian blue †.

795
Pruſſian blue formed of carbone and ammonia.

796
Properties of pruſſic acid.

17. Pruſſic acid thus obtained, is a colourleſs, tranſparent liquid, having a ſtrong odour of peach flowers, or of bitter almonds. This odour impregnates for ſome time the ſaliva of thoſe who reſpire it. The taſte is at firſt ſweetiſh, but ſoon becomes acrid and hot. It is apt to excite coughing, and has a ſtrong tendency to aſſume the gaſeous form, and is therefore ſoon diſſipated from the veſſels which contain it. It has no effect on vegetable blues.

797
Action of heat and light.

18. It is decompoſed at a high temperature; and when expoſed to light, is converted into carbonic acid, ammonia, and carbonated hydrogen gas. It combines with difficulty with alkalies and earths, and without deſtroying their alkaline properties.

798
Of carbonic acid, &c.

19. The carbonic acid drives it off from theſe combinations. It deprives oxymuriatic acid gas of its oxygen, and by this addition changes its properties. It has no action on the metals; but it combines with their oxides, changing the colour, and forming ſalts which are in general inſoluble.

799
Triple compounds

20. This acid has the greateſt tendency to form triple ſalts with the alkaline and metallic baſes. Theſe complex combinations are more permanent and fixed than the ſimple alkaline pruſſiates. They are not decompoſed by carbonic acid, light, air, or the other acids.

800
not eaſily decompoſed

801
Affinities.

21. The affinities of pruſſic acid are the following.

Barytes,
Strontites,
Potaſh,
Soda,
Lime,
Magneſia,
Ammonia.

SECT. XXXIII. *Of Sebacic Acid.*

802
Hiſtory.

1. The penetrating fumes which are exhaled from melted tallow, and which affect the eyes, the noſtrils, and even the lungs, had been long ago obſerved, and Olaus Borrichius has thrown out ſome hints, warning againſt the danger of being expoſed to theſe fumes. But little attention was paid to their nature and properties. Grutzmacher was the firſt who demonſtrated the exiſtence of this acid, in a diſſertation *de oſſium medulla*, printed at Leipſic in the year 1748. Rhodes publiſhed a ſmall work in 1753 at Gottingen, in which he makes particular mention of this acid. The following year appeared a diſſertation by M. Segner, *on the acid of animal fat*, which contained a number of well-conducted experiments. Crell endeavoured to improve the proceſs for the ſeparation and purification of this acid, and to aſcertain the properties of its combinations. Theſe were publiſhed in the Philoſophical Tranſactions for the years 1780 and 1782.

But it appears, as Thenard, who made experiments on this acid, obſerves, that the acid obtained by thoſe who firſt treated of the ſubject, was either the acetic acid, or ſome acid different from the ſebacic, the properties of which are quite diſtinct from thoſe which had been formerly deſcribed.

803
Preparation.

2. The proceſs by which this chemiſt obtained the ſebacic acid is the following. He diſtilled a quantity of hogs lard, and waſhed the product ſeveral times with hot water. He then dropt into it acetate of lead: there was formed a flaky precipitate, which was collected and dried, put into a retort with ſulphuric acid, and heated. The liquor in the receiver had no acid character; but there appeared in the retort a melted matter analogous to fat. This is carefully ſeparated; and after being waſhed, is boiled with water. By the action of heat the whole is diſſolved by the water, and when it cools, cryſtals in the ſhape of needles are depoſited.

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* Fourcroy Connaiſs. Chim. tom. ix. p. 89.

† Ann. de Chim. tom. xi. p. 30.

Theſe are ſebacic acid. To be certain that theſe were not produced by means of the ſulphuric acid, he waſhed the fat which had been diſtilled with water, which was filtered and evaporated, and needles were formed, exhibiting exactly the ſame properties. Or, after having waſhed with water the diſtilled fat, he ſaturated the filtered liquor with potaſh, evaporated it, and dropt into it a ſolution of lead. There was inſtantly formed a ſalt compoſed of the ſebacic acid and lead. This is to be decompoſed as before with ſulphuric acid. This acid has the following properties.

804 Properties.

3. It has no ſmell, a ſlight acid taſte, and reddens ſtrongly the tincture of turnſol. When heated it melts like tallow.

4. It is much more ſoluble in warm than in cold water. Boiling water ſaturated with this acid forms a ſolid maſs on cooling. It cryſtallizes in ſmall needles, but with certain precautions may be obtained in the form of long, large, and very brilliant plates *.

Sect. XXXIV. *Of Uric Acid.*

805 Hiſtory and names.

1. This acid was diſcovered by Scheele in the year 1776. It was at firſt called *lithic acid.* It conſtitutes one of the component parts of urinary calculi, and is alſo found in human urine. There is one ſpecies of calculus which is almoſt entirely compoſed of this ſubſtance. It is that ſpecies which reſembles wood in appearance and colour.

806 Properties. 807 Action of water.

2. This acid, as its properties have been deſcribed by Scheele, is thus characterized. It is inſipid, inodorous, almoſt inſoluble in cold water, and ſoluble only in about 360 parts of boiling water. It ſeparates from this when it cools, into ſmall yellowiſh cryſtals. The ſolution in water reddens the tincture of turnſole.

808 Of acids.

3. There is ſcarcely any action between uric acid and ſulphuric and muriatic acids. It is ſoluble in the concentrated nitric acid, to which it communicates a red colour. It would appear that in this change of colour the nature of the acid is alſo changed, for part of it is converted into oxalic acid. Oxymuriatic acid very readily acts upon uric acid, either by ſuſpending a calculus in the liquid acid, or, which is eaſier, by paſſing a ſtream of oxymuriatic acid gas through water at the bottom of which is placed the uric acid in powder. Its colour becomes pale, the ſurface ſwells up, it ſoftens, and is at laſt converted into a jelly. This part diſappears, and is ſoon diſſolved, giving a milky colour to the liquid. There is extricated by ſlow efferveſcence ſmall bubbles of carbonic acid gas. The liquid by evaporation gives muriate of ammonia, acidulous oxalate of ammonia, both cryſtallized; muriatic acid, and malic acid. Thus the oxymuriatic acid decompoſes the uric acid, and converts it into ammonia, carbonic, oxalic, and malic acids.

809 Of heat.

4. When uric acid is diſtilled, there is a little of it ſublimed without decompoſition. It yields alſo a very ſmall quantity of oil and water, cryſtallized carbonate of ammonia, carbonic acid gas; and there remains behind a very black coal without any alkali, and without any lime.

810 Combination.

5. All theſe facts ſhew that uric acid is a compound of a very peculiar kind, formed of azote, of carbone, of hydrogen and oxygen, and ſuſceptible of a great number of different changes by chemical agents.

Sect. XXXV. *Of Roſacic Acid.*

811 Origin.

1. During certain diſeaſes, the urine, when it cools, depoſites a peculiar ſubſtance which has been denominated from its colour, which reſembles bricks, *lateritious ſediment.* During fevers, this appearance of the urine takes place; and in gouty perſons, at the termination of the paroxyſms, it is very abundant. And when this ſuddenly diſappears, and the urine at the ſame time continues to depoſit this ſubſtance, a relapſe may be dreaded. It appears in the form of red flakes, and adheres ſtrongly to the ſides of the veſſel. If the urine be heated, this ſediment is again diſſolved.

812 Preparation.

2. This ſubſtance was formerly conſidered by chemiſts as uric acid. If into freſh urine a little nitric acid is dropt, it becomes muddy, and a precipitate is formed. The nitric acid, and the ſubſtance to which the name of *roſacic acid* has been given, combine together, and are depoſited. The uric acid being much leſs ſoluble than the roſacic acid, it is very eaſy to ſeparate them. All that is neceſſary is to pour boiling water on the ſediments, and to waſh them on the ſame filter, in which caſe the uric acid remains behind. 813 Properties.

Prouſt, who made experiments on this ſubſtance, conſiders it as another characteriſtic of roſacic acid that it produces with a ſolution of gold, a cloudy precipitate of a violet colour *.

Sect. XXXVI. *Of Amniotic Acid.*

814 Properties.

1. A peculiar acid has been detected in the liquor of the amnios of the cow. This was diſcovered by Buniva and Vauquelin. This acid is concrete, white, and brilliant, has a very ſlight acid taſte, and reddens the tincture of turnſole. It is little ſoluble in cold water, but diſſolves more readily in boiling water, from whence it is depoſited by cooling, in long needle-ſhaped cryſtals. When this acid is expoſed to heat, it ſwells up, and exhales an odour of ammonia ſenſibly mixed with pruſſic acid. It leaves behind a voluminous coal.

815 And diſtinctive characters.

2. It ſeems at firſt to have ſome analogy with the ſaclactic and uric acids, but this is not really the caſe. The ſaclactic acid does not furniſh ammonia by diſtillation; the uric acid yields ammonia and pruſſic acid by heat, but it is not equally ſoluble in warm water, and does not cryſtallize, in long, white, brilliant needles, nor is it ſoluble in boiling alcohol, as the amniotic acid is †.

Chap. XI. Of INFLAMMABLE SUBSTANCES.

Introduction.

The claſs of bodies which we are to examine in this chapter, under the title of inflammable ſubſtances, are *alcohol*, *ether*, and *oils*. Theſe ſubſtances are cloſely allied to many of the bodies which were treated of in the laſt chapter. Their conſtituent parts are the ſame with many of the vegetable acids, arranged, however, in different proportions, and totally different in their properties and effects. The elements of theſe inflammable ſubſtances are carbone and hydrogen chiefly, but in ſome there is a triple compound of carbone, of hydrogen and oxygen; the latter does not exiſt in that quantity as to exhibit acid properties, or theſe properties are concealed by the proportions of the other conſtituent parts. It was therefore thought neceſſary to treat of theſe ſubſtances in this place, that we might be early acquainted with their properties, ſome of which are of great importance in chemical reſearches, particularly their effects on many ſaline bodies. They may be regarded, therefore, as valuable inſtruments of chemical analyſis. We ſhall conſider the inflammable ſubſtances in the four following ſections, namely; 1. Alcohol, 2. Ether, 3. Fixed oils, and 4. Volatile oils.

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* *Annal. de Chim.* tom. xxxix. p. 192.

* *Ann. de Chim.* tom. xxxvi. p. 265.

† *Ann. de Chim.* tom. xxxiii. p. 279.

SECT. I. *Of ALCOHOL.*

817 Preparation. 1. When vegetable matters have been ſubjected to the vinous fermentation, the fluid is totally changed. It is converted into a ſubſtance called *wine* or *beer*, according to the nature of the materials from which it has been prepared. When this product, the wine or beer, is ſubjected to another proceſs, a very different product is obtained. By diſtillation a fluid is obtained of very different properties from the beer or wine from which it is extracted. This liquid, when it is perfectly pure, is known in chemiſtry by the name of *alcohol*, or *ſpirit of wine*, becauſe it is produced from wine. It is ſometimes denominated alſo *ardent ſpirit*, from its effects. Ardent ſpirit, as it is firſt obtained by diſtillation, is to be conſidered as a mixture of alcohol and water, becauſe the alcohol in the proceſs of diſtillation is condenſed by water. In this ſtate, ardent ſpirit is different in flavour, in colour and in ſtrength, according to the nature of the materials from which it is obtained, and hence in common language it is diſtinguiſhed by different names. When it is obtained from the fermented juice of the grape, it is known by the name of *brandy*; from that of the ſugar-cane, by that of *rum*; and from that of farinaceous ſubſtances by that of *whiſky*. All theſe ſubſtances, therefore, are to be conſidered as compoſed of alcohol, or pure ſpirit of wine, water, and a peculiar oil, to which the flavour is owing.

818 Different names.

819 Hiſtory. Ardent ſpirit, it is ſuppoſed, was known in the dark ages. It does not appear, from any of the writings of the Greeks or Romans, that they were acquainted with ſuch a liquor. The preparation of it from wine, and even the diſcovery of alcohol, or pure ſpirit itſelf, is aſcribed to Arnold de Villa Nova, who lived in the 13th century.

820 Purification. 2. Ardent ſpirit thus obtained, it has been obſerved, is a mixture of alcohol or pure ſpirit, water and oil, with ſome colouring matter. To purify it from theſe ſubſtances, it is again diſtilled; and to have it perfectly pure, this proceſs muſt be repeated ſeveral times. When ardent ſpirit is diſtilled for the firſt time, after it is extracted from the fermented liquors, it is diſtinguiſhed by the name of rectified ſpirits. The proceſs which is recommended by ſome is the following. Diſtil it in a water bath, till one fourth of the quantity has paſſed over; then diſtil it again for ſeveral times, taking only the firſt half of the product. Mix all theſe products together, and diſtil them with a very gentle heat; the firſt half of the liquor which paſſes over, is the pureſt alcohol that can be obtained; the remainder may be reſerved for ordinary purpoſes †. Even in this ſtate, the alcohol thus obtained, contains a certain proportion of water, to ſeparate which, Boerhaave has given a very good proceſs, by means of an alkali. Take a quantity of carbonate of potaſh which has been expoſed to a red heat, to ſeparate the moiſture; reduce it to powder, and put it into the ſpirit. This ſalt, on account of its ſtrong attraction for water, combines with the water of the alcohol; and this ſolution of the alkali having the greater ſpecific gravity, falls to the bottom. The alcohol which remains at the top may be eaſily ſeparated. To purify this alcohol, from a ſmall quantity of potaſh which it holds in ſolution, it may be rediſtilled in a water bath. It ought to be obſerved, however, that the diſtillation ſhould not be carried on till the whole of the alcohol is driven off, becauſe towards the end of the proceſs, it carries part of the potaſh along with it.

821 Properties. 3. Alcohol thus prepared and purified, is a light, tranſparent, and colourleſs liquor, of a ſharp, penetrating, agreeable ſmell, and of a warm, ſtimulating, acrid taſte. It has the property, in a much greater degree than wine, of producing intoxication. The ſpecific gravity of alcohol when perfectly pure, is 0.800, but the ſtrongeſt ſpirit which is afforded by mere diſtillation, according to Mr Nicholſon, is 0.820 at the temperature of 71°. The alcohol or rectified ſpirit of commerce, has rarely a ſpecific gravity below 0.8371.

822 Volatile. 4. When alcohol is expoſed to the air at a temperature between 50° and 60°, it evaporates, and when it is pure, without leaving any reſiduum. By this rapid evaporation it produces great cold, which is very ſenſibly felt by dipping the fingers in alcohol, and expoſing them to the air. It boils at the temperature of 176°, and is then converted into an elaſtic fluid. In the vacuum of an air-pump it boils at 56°. It has never yet been frozen by the greateſt degree of cold to which it has been expoſed. It remains fluid when the thermometer ſtands at —69°. When it is paſſed through a red-hot porcelain tube, it is decompoſed, and converted into carbonic acid gas, carbonated hydrogen gas, and water.

823 Action of heat.

824 Phoſphorus. 5. With the aid of heat, alcohol diſſolves a ſmall quantity of phoſphorus. When this ſolution, which has a fetid odour, is precipitated, by dropping a little of it into water, it becomes luminous in the dark. There ariſe jets of flame from the ſurface of the water; and there is formed an oxide of phoſphorus in the ſtate of white powder. Alcohol ſeems alſo capable of diſſolving phoſphorated hydrogen gas.

825 Sulphur. 6. There is no action between alcohol and ſulphur neither at the ordinary temperature, nor even when they are boiled together; but when the two bodies are brought in contact with each other in the ſtate of vapour, they combine readily, and there is formed a fetid ſulphurated alcohol, which depoſits a ſmall quantity of white ſulphur, and becomes muddy in cooling. The ſulphur is precipitated by water, and gives about $\frac{1}{60}$th part. Alcohol combines ſtill more readily with ſulphurated hydrogen gas, which communicates to the alcohol a little colour, and in this combination is decompoſed with more facility by oxygen gas, and all other oxygenated bodies, than when it is in the

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† *Fourcroy Connaiſs. Chim.* tom. viii. p. 143.

ſtate of gas. Alcohol combines with ſulphurated hydrogen gas, which is contained in mineral waters, and deprives them of this gas by diſtillation.

526 Of acids. 7. The ſtrong acids have a very powerful effect on alcohol. It is decompoſed by the ſulphuric, the nitric, the oxymuriatic, and the acetic acids; and the product of this decompoſition varies according to the nature of the acid, its ſtrength, and the proportions in which it is employed. Some of the acids are ſoluble in alcohol. With the aid of heat, it diſſolves the boracic acid, which communicates to it the property of burning with a green flame. It alſo holds in ſolution carbonic acid gas in greater proportion than its own bulk. It precipitates from water, on the contrary, the phoſphoric acid, almoſt in the concrete ſtate, and alſo the metallic acids which are ſoluble in this liquid.

527 Of water. 8. Alcohol combines with water in all proportions. The affinity between the two fluids is ſo ſtrong that water is capable of ſeparating from alcohol many bodies with which it is combined, while the alcohol decompoſes many ſaline ſolutions, and precipitates the ſalt. When water and alcohol are combined together, there is an increaſe of temperature, which ſhews that there is a condenſation of the two liquids. Accordingly it is found, that the denſity or ſpecific gravity of the mixture is greater than the mean of the uncombined liquids. This denſity varies according to the different proportions of the alcohol and water which are employed. In conſequence of this variation, it becomes an object of conſiderable importance to be able to aſcertain the ſtrength of ſpirits; that is, the proportions of alcohol and water of different degrees of denſity or ſpecific gravity. This object is important, both in a political and commercial view. For the purpoſes of commerce, various inſtruments have been contrived, and tables conſtructed, for the conveniency of thoſe who are concerned in the purchaſe and ſale of ſpirituous liquors. For the purpoſes of revenue, a moſt elaborate and minute ſet of experiments was inſtituted by Sir Charles Blagden, who was expreſsly employed by the Britiſh government to aſcertain the relative value or ſtrength of ardent ſpirit at different temperatures and different ſpecific gravities. An account of theſe experiments was publiſhed in the Philoſophical Tranſactions for the year 1790. Tables which ſhew the reſult of the experiments, were publiſhed by Mr Gilpin in 1794; but as theſe are not immediately connected with the elements of chemiſtry, we refer our readers to the original papers, and to the article *Spirituous Liquors*, in this work.

528 Alkalies and ſalts. 9. Alcohol diſſolves the fixed alkalies in the pure ſtate, and forms with them an acrid ſolution of a reddiſh colour. The ſolution of potaſh in alcohol was formerly denominated *the acrid tincture of tartar*. It is in this way that the fixed alkalies are obtained in their pureſt ſtate. Alcohol, therefore, becomes a valuable inſtrument of analyſis for ſeparating the fixed alkalies from a great number of extraneous ſubſtances. Ammonia alſo combines with alcohol by the aſſiſtance of heat. The ammonia with a higher temperature is driven off, and carries with it part of the alcohol. Many of the ſaline bodies may be diſſolved in alcohol, and on this account alſo it is valuable to the chemiſt in his reſearches. Tables have been conſtructed, ſhewing the quantity of different ſalts which may be diſſolved at different temperatures. The following tables were drawn up from the experiments of M. Guyton *.

I. *Table of Salts which are readily Diſſolved.*

	Temperature.	Grains.	
240 grains of alcohol diſſolve at	54.5°	240	Nitrate of cobalt.
	54.5	240	copper.
	54.5	240	Muriate of zinc.
	54.5	240	alumina.
	54.5	240	Nitrate of alumina.
	113.	240	Acetate of lead.
	180.5	694	Nitrate of magneſia.
	180.5	1313	Muriate
	180.5	240	of iron.
	180.5	240	of copper.
			Nitrate of zinc decompoſed.
			Nitrate of iron partly decompoſed.
			Nitrate of biſmuth.

II. *Table of Salts that are little Soluble.*

	Grains.	
240 grains of alcohol at the boiling temperarure diſſolve	240	Muriate of lime.
	214	Nitrate of ammonia.
	212	Oxymuriate of mercury.
	112	Acetate of ſoda.
	100	Nitrate of ſilver.
	23	Nitrate of ſoda.
	18	Acetate of copper.
	17	Muriate of ammonia.
	9	Arſeniate of potaſh.
	9	Superoxalate of potaſh.
	5	Nitrate of potaſh.
	5	Muriate of potaſh.
	4	Arſeniate of ſoda.
	1	Tartrate of potaſh.

III. *Salts that are Inſoluble.*

Borax,
Tartar,
Alum,
Sulphate of ammonia,
iron,
copper,
zinc,
ſoda,
potaſh,
lime,
ſilver,
mercury,
Tartrate of ſoda,
Nitrate of lead,
mercury,
Muriate of lead,
Carbonate of potaſh,
ſoda.

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* *Journ. de Phyſique*, 1785, p. 65.

The following table drawn up by Mr Kirwan, ſhews the quantity of ſalts that are ſoluble in 100 parts of alcohol of different denſities. The temperature in which the ſolutions were made was from 50° to 80° †.

Salts.	*Alcohol of*				
	0.900	0.872	0.848	0.834	0.817
Sulphate of ſoda.	0.	0.	0.	0.	0.
Sulphate of magneſia.	1.	1.	0.	0.	0.
Nitrate of potaſh.	2.76	1.		0.	0.
Nitrate of ſoda.	10.5	6.		0.38	0.
Muriate of potaſh.	4.62	1.66	0	0.38	0.
Muriate of ſoda.	5.8	3.67	0.	0.5	0.
Muriate of ammonia.	6.5	4.75	0.	1.5	0.
Muriate of magneſia dried at 120°	21.25	0.	23.75	36.25	50.
Muriate of barytes. Do. cryſtallized.	1. 1.56	0. 0.	0.29 0.43	0.185 0.32	0.09 0.06
Acetate of lime.	2.4	0.	4.12	4.75	4.88

829 Compoſition. 12. A great variety of different opinions have been propoſed with regard to the compoſition of alcohol. It had been obſerved, in burning this combuſtible ſubſtance, in cloſe veſſels, that water was formed. Some philoſophers had even obſerved that the quantity of water obtained by the combuſtion of alcohol, was greater than the whole weight of the alcohol which was conſumed. From obſerving this circumſtance, it was ſuppoſed to conſiſt of water, combined with an acid, an oil, or phlogiſton, according to the views and theories of different philoſophers.

830 According to Lavoiſier. It is to the experiments of Lavoiſier that we are indebted for aſcertaining the real conſtituent parts of this ſubſtance. He burnt in a proper apparatus, with a known quantity of oxygen gas, 76.7083 grs. troy of alcohol, and after the combuſtion, carbonic acid gas and water were found to be the only products; and by eſtimating the oxygen gas conſumed, the quantity of carbonic acid and of water which were formed, it appeared that the quantity of alcohol conſumed was compoſed of

22.840 carbone,
6.030 hydrogen,
47.830 water.

76.700

831 To Fourcroy. But it has been ſince proved, by the experiments of Fourcroy and Vauquelin, that oxygen is a component part of alcohol; for when they mixed together equal parts of alcohol and concentrated ſulphuric acid, and while ether is formed from it, there was alſo at the ſame time a production of water; the alcohol in this caſe was decompoſed, but the ſulphuric acid ſuffered no change. The oxygen, therefore, which combined with the hydrogen in the formation of water, muſt have come from the alcohol *.

SECT. II. *Of Ether.*

832 Formation. By the action of different acids with alcohol, the latter is decompoſed, and different products are obtained, according to the proportions of the acid employed, and the heat which is applied. When the acid and the alkali are in a certain proportion, and are expoſed to a moderate temperature, the product is a peculiar ſubſtance which has received the name of *ether*. Ether has been obtained by the action of different acids on alcohol, and hence it has received different names, as *ſulphuric ether*, *nitric ether*, *muriatic ether*. The firſt, namely ſulphuric ether, which ſeems to have been longeſt known, and is moſt eaſily obtained, has excited the greateſt attention among chemiſts. We ſhall therefore conſider it firſt. 833 Names.

I. Of Sulphuric Ether.

834 Hiſtory. 1. It appears from different paſſages in the writings of the earlier chemiſts, that the knowledge of ſulphuric ether was among their ſecrets. It was then called *oleum vitrioli dulce*. The method of preparing it is deſcribed in a book publiſhed at Nuremberg about the year 1540. But the nature of this ſubſtance was not much attended to till the year 1730, when a certain quantity was preſented to the Royal Society by Dr Frobenius, with a paper which was publiſhed in their tranſactions for that year, containing an account of a number of experiments which were made upon

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† *Min. Wat.* p. 274.

* *Nichol. Jour.* i. p. 191.

it. It was long known under the name of *naphtha* among the German chemiſts.

834 Preparation.

2. The following is the proceſs by which ſulphuric ether may be obtained. Equal parts of concentrated ſulphuric acid and alcohol are put into a retort, to which a receiver is to be adapted and luted. Or perhaps it is better to add the acid by ſmall portions at a time, that the action may not be too violent, and the heat produced too great. The receiver ſhould be immerſed in cold water, or ſurrounded with ice, or it may be kept cool by the application of wet cloths, over which a ſmall ſtream of water is directed. Heat is then applied, and the firſt product which comes over is a fragrant ſpirit of wine; but as ſoon as the mixture begins to boil, the ether comes over, is condenſed by the cold, and runs in ſtreams down the ſides of the receiver. When the quantity obtained amounts to about one half of the alcohol employed, the proceſs ſhould be ſtopped, and the receiver unluted and removed; but if it be continued, white fumes begin to come off, which are known to be the fumes of ſulphurous acid. After this there riſes a light yellowiſh coloured oil, which has been called *the ſweet oil of wine.* The heat ſhould now be moderated after the ether has paſſed over, becauſe the matter contained in the retort becomes black, thick, and ſwells conſiderably. When the whole of the ſweet oil has come over, there is ſtill an evolution of ſulphurous acid, which becomes thicker and thicker, till at laſt there is nothing but a dark coloured ſulphuric acid.

835 Purification.

3. The ether which is obtained by this proceſs is impure. It is generally contaminated with ſulphurous acid. To purify it, it has been uſual to mix a quantity of potaſh with the fluid, and to diſtil it over again. The acid in this caſe combines with the potaſh, and the ether being ſeparated, paſſes over into the receiver. Dizé, however, conſidering this proceſs as tedious and uncertain, has propoſed other ſubſtances in the room of potaſh, and he has tried ſeveral metallic oxides, ſuch as the red oxide of lead, the yellow oxide of iron, the red oxide of mercury, and the black oxide of manganeſe. But after a variety of experiments, he is of opinion, that the black oxide of manganeſe is the moſt convenient for the purification of ether. It is mixed with ether, allowed to remain ſome time, and is to be frequently agitated. The oxygen of the manganeſe combines with the ſulphurous acid, and converts it into ſulphuric acid, which is a more fixed body than the ſulphurous acid *.

To ſeparate the liquid from the ſulphurous acid, Prouſt recommends the following method, which he ſays is employed in the large way, as by far the moſt preferable. Introduce into a bottle which is $\frac{3}{4}$ths filled with impure ether, ſome water, and a portion of ſlaked lime. Agitate the bottle ſtrongly, and do not open it to examine its odour, till after it has remained for ſome minutes in cold water, and when the vapour within the bottle has ceaſed to exert its elaſtic force againſt the cork; if the ſulphurous ſmell is not entirely removed, the proceſs is to be repeated till it is completely deſtroyed. This method, which was employed by Woulfe, Prouſt prefers on account of its economy, particularly as it affords at the ſame time a ſulphite of lime, which is formed by the combination of the ſulphurous acid with the lime. When the liquids have ſeparated, the ether which ſwims on the top, may be drawn off by means of a ſyphon, and it may be introduced into a retort to be rectified by diſtillation *.

836 Properties.

4. The ether which is thus obtained, is a tranſparent colourleſs fluid, of a very fragrant ſmell, and a hot pungent taſte. The ſpecific gravity is only 0.7581, ſo that it is conſiderably lighter than alcohol. It is extremely volatile, ſo that when it is agitated, or poured from one veſſel to another, it is inſtantly diſſipated. It produces ſo great a degree of cold, that water may be frozen by means of it. It riſes in the ſtate of gas which burns with great rapidity, and the air which holds ether in ſolution may be paſſed through water without being deprived of its combuſtibility or fragrance.

837 Action of heat.

5. It boils in the open air at the temperature of 98°, and in the vacuum of an air pump at —20°, ſo that it would conſtantly remain in the ſtate of gas if the preſſure of the air were removed.

When ether is kindled in the open air, it burns very readily. The electric ſpark alſo inflames it. It burns with a copious white flame, and leaves behind it a black trace on the ſurface of bodies expoſed to the flame. Lavoiſier has obſerved that there is always formed an acid during the combuſtion of this liquid; and Scheele ſays that the reſiduum of ether burnt over a little water, contains ſulphuric acid. When the ether is expoſed to a cold of —46°, it freezes and cryſtallizes. It is decompoſed when the vapour is paſſed through a red-hot porcelain tube, and the product is carbonated hydrogen gas.

838 Increaſes the volume of gaſes.

6. Dr Prieſtley diſcovered that ether agitated with any kind of gas, greatly increaſed its volume, and in moſt caſes doubled it. Mr Cruickſhank made a ſimilar experiment, by agitating ſome oxygen gas with a little ether. The bulk was exactly doubled. In this ſtate the gas did not explode, but when one part of this mixture was added to three parts of oxygen, an ignited body or the electric ſpark produced a dreadful exploſion. The products were water, with 2$\frac{1}{3}$d carbonic acid gas. Hence it would appear, Mr Cruickſhank obſerves, that one part of this vapour requires about ſeven of oxygen to ſaturate it; and according to this experiment, the proportion of carbone to hydrogen in the vapour of ether or ether itſelf, ſhould be as five to one †.

839 Action of phoſphorus.

7. Phoſphorus is diſſolved in ſmall quantity in ether, and produces a tranſparent ſolution; but when alcohol is added to the ſolution, it becomes milky.

840 Of acids.

8. Sulphuric acid has a peculiar action on ether, by converting it into a kind of oil, which is called *the ſweet oil of wine.* This is one of the products in the preparation of ſulphuric ether. When a ſmall quantity of ether is introduced into a bottle filled with oxymuriatic acid gas, it explodes, and inflames; or if paper moiſtened with ether be introduced, the ſame effect follows. Carbonic acid gas is produced, and charcoal is depoſited on the ſides of the bottle.

841 Compoſition.

9. Various theories have been propoſed, to account for the production of ether. From the manner of its production by means of ſulphuric acid, it was natural to ſuppoſe that this acid formed one of its component parts. This accordingly became a general opinion, till it was found that the ſulphuric acid ſuffered no change in the proceſs, but merely aſſiſted or diſpoſed the alcohol to

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* *Jour. de Phyſ.* xlvi. p. 298.

* *Ann. de Chim.* xlii. p. 257.

† *Nichol. Jour.* v. p. 205.

that change which it undergoes when it is converted into ether. According to Macquer, the alcohol has not been changed, but merely deprived of the whole of its water. Scheele ſuppoſed, that ether was alcohol deprived of its phlogiſton; and when the new theories were introduced, ether was conſidered as a combination of alcohol and oxygen.

10. The experiments and reſearches of Fourcroy and Vauquelin have thrown new light on this ſubject, and have led to different views of the nature and compoſition of ether. According to the reſult of theſe experiments, ether contains a ſmaller proportion of carbone, but a greater proportion of hydrogen and oxygen. From their experiments, and from thoſe of others, it appears that the changes induced by the action of ſulphuric acid on alcohol, depend on the quantity and ſtrength of the acid, and the temperature.

A. Equal parts of concentrated ſulphuric acid and alcohol mixed together raiſe the temperature to 189°. Bubbles of gas are emitted; the liquid becomes turbid, and at the end of ſome hours aſſumes a deep red colour.

B. A mixture of two parts ſulphuric acid, and one part alcohol, produces a temperature of 200°. The mixture becomes inſtantly of a deep red colour, paſſes to black a few days after, and diffuſes an odour which is perceptibly that of ether.

C. When equal parts of ſulphuric acid and alcohol are expoſed to the action of heat, in a proper apparatus, ſuch as is employed for the preparation of ether, the following phenomena are obſerved.

a. When the temperature is raiſed to 207°, the liquid boils; there is produced a fluid which is condenſed by cold, into a light, colourleſs and fragrant liquor, which from its properties has received the name of ether. If the proceſs be properly conducted, no permanent gas is evolved, till about $\frac{1}{2}$ of the alcohol is converted into ether.

b. If, as ſoon as the ſulphurous acid appears, the receiver be changed, there is no longer any production of ether; but the ſweet oil of wine, water, and acetic acid are formed, without a ſingle particle of carbonic acid. When the ſulphuric acid makes about $\frac{4}{5}$ths of the maſs which remains in the retort, there is evolved an inflammable gas, which has the odour of ether, and which burns with a white oily flame. This is the gas which the Dutch chemiſts have called *carbonated hydrogen gas*, or *olefiant gas*, becauſe when it is mixed with oxymuriatic acid it forms oil. At this period, the temperature of the matter contained in the retort is elevated to 230° or 234°.

c. When the ſweet oil of wine ceaſes to flow, if the receiver be again changed, there is only ſulphurous acid emitted, water which was previouſly formed, carbonic acid gas; and there remains only in the retort, a maſs which conſiſts chiefly of ſulphuric acid thickened with charcoal.

842 References. From theſe phenomena, which were uniform and conſtant, the following concluſions were drawn.

a. A ſmall quantity of ether is formed ſpontaneouſly without the aid of heat, by the combination of two parts of ſulphuric acid and one part of alcohol.

b. As ſoon as the ether is formed, and there is at the ſame time a production of water, the ſulphuric acid undergoes no change in its intimate nature, while the firſt of theſe compoſitions takes place.

c. When the ſulphurous acid appears, there is no longer any production of ether; but then there paſs over the ſweet oil of wine, water, and acetic acid.

d. The ſweet oil of wine having ceaſed to paſs over, nothing is obtained but ſulphurous acid, carbonic acid, and at laſt ſulphur, if the diſtillation be continued.

The operation of ether, then, may be divided into three periods; the firſt, in which a ſmall quantity of ether and water is formed, without the aſſiſtance of heat; the ſecond period, in which the greateſt quantity of ether which can be obtained without the evolution of ſulphurous acid at a temperature of 207°; and the third, in which the ſweet oil of wine, olefiant gas, acetic acid, ſulphurous and carbonic acid are produced, while the temperature of the mixture is raiſed to 230° and 234°. In all theſe three periods there is only one common circumſtance, and this is, the continual formation of water from the beginning to the end of the operation.

843 Theory. On theſe obſervations, Fourcroy and Vauquelin have eſtabliſhed their theory of the formation of ether.* In the caſe in which ether is formed by the ſimple mixture of alcohol and ſulphuric acid, without the aid of heat, the formation which appears by heat as well as by the black precipitate, the charcoal which is ſeparated without the production of ſulphurous acid, proves that the ſulphuric acid acts in a different manner on alcohol from what was ſuppoſed. This acid is not decompoſed by charcoal at that temperature. There is no action between theſe two bodies in the cold, nor is there any action between this acid and alcohol; for in that caſe, ſulphurous acid would be formed, of which not the ſmalleſt trace can be perceived at the beginning of the operation. Recourſe then muſt be had to a different action, namely the ſtrong affinity which exiſts between ſulphuric acid and water. It is this which determines the union of the conſtituent principles of water exiſting in the alcohol, and with which this acid comes in contact; but this action muſt be very limited. There is ſoon eſtabliſhed a balance of affinities, and no farther change takes place.

If then it be proved that ether is formed by the mixture of certain quantities of ſulphuric acid and alcohol, it muſt obviouſly follow, that a maſs of alcohol may be completely converted into ether, water, and acetic acid, by increaſing the quantity of ſulphuric acid; and it is equally obvious, that this acid would undergo no change but that of being diluted with water.

It is not neceſſary to ſuppoſe, according to this theory, that ether is alcohol deprived of a certain portion of oxygen and hydrogen, for there is ſeparated at the ſame time a quantity of charcoal proportionally greater than that of the hydrogen; and it may be conceived, that the oxygen which is combined in this caſe with the hydrogen, to form water, would not only ſaturate this hydrogen in the alcohol, but that it would ſaturate at the ſame time the carbone which has been precipitated. Thus, then, in place of conſidering ether as alcohol with a ſmaller proportion of hydrogen and oxygen, if we take into account the carbone which is precipitated, and the ſmall quantity of hydrogen contained in the water that is formed, it muſt be conſidered as alcohol with a greater proportion of hydrogen and oxygen. Such ſeems to be the nature of the ſpontaneous action between ſulphuric acid and alcohol without the aid of heat.

But when the mixture is ſubjected to heat, the production of ether is more complicated, and the products more numerous.

It ought to be obſerved, that the mixture of ſulphuric acid and alcohol in equal proportions, boils only at the temperature of 207°, whilſt alcohol alone boils at 176°; whence we muſt conclude, that the alcohol is retained by the affinity of the ſulphuric acid, which fixes it. Now, if we compare what happens in this caſe to the change produced on all other vegetable matter expoſed to the action of heat, in which the principles are volatilized, according to the order of their affinity for caloric, carrying with them a ſmall quantity of the more fixed elements, in proportion as the ſulphuric acid attracts the alcohol and the water, of which it favours the formation, the ether which is evolved attracts caloric, and is ſublimed; and when the greateſt part of the alcohol has been changed into ether, the mixture becomes denſer, the heat more conſiderable, and the affinity of the ſulphuric acid for the undecompoſed alcohol being increaſed, the acid is decompoſed, ſo that on one hand its oxygen combines with the hydrogen of the alcohol, and forms water, which riſes gradually into vapour, whilſt, on the other, the ether retaining a greater quantity of carbone, with which it riſes in vapours at this temperature, affords the ſweet oil of wine, which ought to be conſidered as an ether with a greater proportion of carbone. This ſeems to be proved by its greater ſpecific gravity, leſs volatility, and its citron colour.

11. From this theory the ingenious authors of it have deduced the following practical concluſions.

a. The formation of ether is not owing, as was ſuppoſed, to the immediate action of the principles of the ſulphuric acid on thoſe of alcohol, but to the reaction of the principles of the latter on each other, and particularly of its oxygen and hydrogen, occaſioned by the ſulphuric acid.

b. A portion of alcohol may be converted into ether without the aid of heat, by increaſing ſufficiently the proportion of ſulphuric acid.

c. With regard to the change which takes place on alcohol in the production of ether, the proceſs may be divided into two periods. In the one, ether and water are only produced; in the other, ſweet oil of wine, water, and ſulphuric acid.

d. During the formation of ether, the ſulphuric acid is not decompoſed, and there is no production of the ſweet oil of wine. When the latter makes its appearance, there is given out no more, or at leaſt very little, ether; and at the ſame time the ſulphuric acid is decompoſed by hydrogen ſolely, whence ſulphurous acid is formed.

e. The formation of the ſweet oil of wine may be avoided, by keeping the temperature of the mixture between 200° and 207°. This is managed by introducing a few drops of water into the retort.

f. And laſtly, alcohol differs from ether, in containing more carbone, leſs hydrogen and oxygen, and the ſweet oil of wine is to ether very near what alcohol is to the latter *.

II. Of Nitric Ether.

1. Nitric acid, or rather nitrous acid, acts with much greater violence on alcohol than ſulphuric acid. In this caſe the action muſt be moderated, either by diluting the two liquids, or by cooling the mixture. The firſt eaſy proceſs which was propoſed for the preparation of nitric ether, was given by Navier, a phyſician of Chalons.

844 Preparation by Navier.

2. The proceſs of Navier is the following. He put into a ſtrong bottle 12 parts of pure alcohol, and plunged it into cold water, or rather ſurrounded it with ice. To this he added, in different portions, eight parts of concentrated nitric acid, agitating the mixture, after every addition. The bottle is then ſtopped with a cork, which is ſecured with leather, and the mixture is ſet in a convenient place, to avoid the danger of accidents on the burſting of the bottle, which ſometimes happens. At the end of ſome hours, bubbles riſe from the bottom of the veſſel, and drops are collected on the ſurface of the liquid, which gradually form a ſtratum of ether. This action continues for the ſpace of ſix days. When it ceaſes, the cork is to be pierced with a needle, to permit the eſcape of a quantity of nitrous gas, which, without this precaution, would ruſh out rapidly on uncorking the bottle, and would carry along with it the ether, which would be loſt. When the gas is diſſipated, the cork is to be drawn out, and the whole liquid in the bottle is to be poured into a funnel. The ether ſwims on the top, and the remaining liquor being heavier, is allowed to paſs off, and the ether is retained.

845 Beaumè.

3. This proceſs was improved by Beaumè. He found that the greateſt produce of ether was from two parts of acid to three of alcohol. He directed both ingredients to be uſed in the coldeſt ſtate, by keeping each in melting ice, and the bottle in which the mixture is made, to be kept equally cold. In this proportion of ingredients, the danger of exploſion is avoided, and the low temperature greatly moderates the violent action. The mixture in the bottle is always to be well agitated before any new addition of acid is made, and by this means the accumulation in any particular ſpot is prevented. The ether begins to form, as in the former proceſs, in the courſe of a few hours, and if the bottle is allowed to remain undiſturbed for eight or ten days, a quantity of ether equal to one half the weight of the alcohol is obtained, after which no more is produced.

846 Black's proceſs.

4. Dr Black's proceſs is deſcribed by himſelf in the following words. "Into a ſtrong phial, having a ground ſtopper, I firſt pour four ounces of ſtrong pale nitric acid. I then add three ounces of water, pouring it in ſo gently, that it ſwims on the ſurface of the acid. I then pour in after the ſame manner ſix ounces of alcohol. I put in the ſtopper ſlightly, and I ſet the phial in a tub of water and ice. The acid mixes ſlowly with the water, and in a diluted ſtate comes in contact with the alcohol on which it immediately acts, and ether is produced ſlowly and quietly. The liquor gets a dim appearance, becauſe imperceptible bubbles are formed, which get to the top, and having collect-

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* *Fourcroy Connaiſſ. Chim.* tom. viii. p. 162—166.

ed to a certain degree, they lift the ſtopper, and eſcape (s). After eight or ten days I find upwards of three ounces of nitric ether, though I am certain by the ſmell, that much eſcapes with the vapour. This is however, a certain, eaſy, and ſafe proceſs, though it is ſlow and imperfect *."

* Black's Lect. ii. 324.

847
Laplanche's

5. Many other proceſſes have been propoſed for the preparation of nitric ether. Laplanche, a Pariſian apothecary, has employed nitre, which he introduced into a tubulated ſtone-ware retort, and firſt pouring the concentrated ſulphuric acid, and then the alcohol upon it, there is an immediate production of ether; but by this proceſs it is ſuſpected that the nitric ether may be mixed with ſulphuric ether. He has therefore propoſed another proceſs, which is more complicated †.

† Fourcroy, Connaiſs. Chim tom. viii. p. 170.

848
Chaptal's.

6. The proceſs which has been propoſed by Chaptal, is, according to Prouſt, the beſt that can be adopted. This proceſs, with ſome additions and alterations, which he has found it neceſſary to make from his own experience, is the following. The proportions which he employs are, 32 ounces of alcohol, and 24 of nitric acid. Theſe are introduced into a large retort, which is to be luted to a globular glaſs veſſel, furniſhed with a tube of ſafety. A tube paſſes from this globe to a ſecond, which is alſo furniſhed with a tube of ſafety. One or two ounces of water ſhould be introduced into the ſecond globe to ſhut up its tube of ſafety. Three bottles of Woulfe's apparatus, containing from 64 to 80 ounces of liquid, are then to be connected with the ſecond globe. Theſe bottles are half filled with alcohol. The alcohol and the acid are poured into the retort, and are mixed by agitation. The retort is luted to the glaſs globe, and heat is applied, with this precaution, that it muſt be removed as ſoon as there is any efferveſcence. The proceſs now goes on, and requires no farther attention than occaſionally cooling the globes and the bottles with cloths moiſtened with ſnow-water. The greateſt part of the ether which is formed, condenſes in the firſt bottle, and gives the alcohol a yellow colour. It then paſſes to the ſecond, in which the colour is lighter, and at laſt to the third, where there is little perceptible change. To ſeparate the ether of the firſt bottle, the mixture is to be ſaturated with an alkali, and diſtilled ‡.

‡ Ann. de Chim. tom. xlii. p. 261.

849
Purification.

7. But by whatever proceſs nitric ether is obtained, it requires to be purified, to ſeparate the acid and alcohol, which are generally mixed with it. This is done by diſtilling it from potaſh, which reduces its quantity, for the diſtillation muſt not be continued longer than when two-thirds or one-half of the firſt ether has come over. To purify this ſtill more, it is directed to be mixed with one-fifth of nitrous acid, and diſtilled again, taking two-thirds of the product ſet apart, and rectify it from an alkali. The remainder which comes over is a leſs pure ether, which has been known under the name of *Hoffman's mineral anodyne liquor*. What remains in the retort has been called *dulcified ſpirit of nitre*.

850
Properties.

8. Nitric ether thus obtained, is a yellowiſh coloured liquid, equally volatile as ſulphuric ether. Its odour, though ſtronger and leſs ſweet, is analogous to the ſulphuric ether. The taſte is hot and more diſagreeable. It is often of a deeper yellow colour, and always contains a ſmall exceſs of acid and nitrous gas. The ſtopper is frequently driven out of the bottle in which it is kept, for there is a conſtant evolution of a conſiderable quantity of gas.

851
Burns with a brilliant flame.

9. When it is ſet fire to, it gives out a more brilliant flame, and a denſer ſmoke, than ſulphuric ether; and it depoſits a greater quantity of charcoal. When it is long kept in a cloſe veſſel, there is formed ſome water, holding a ſmall quantity of oxalic acid in ſolution, which falls to the bottom of the veſſel.

852
Analogous to ſulphuric ether.

10. Nitric ether is not only analogous to ſulphuric ether in its properties, but alſo in the nature of the proceſs by which it is obtained, and in the other products which accompany this proceſs. But in the production of nitric ether, there is no depoſition of charcoal, and the acid itſelf is decompoſed. This appears from the great quantity of nitrous gas which is evolved during the proceſs; and the reaſon aſſigned for the diſappearance of the charcoal is, that the oxygen of the acid combines with it, and forms carbonic acid, which eſcapes in the form of gas. The products which are generally obtained in the proceſſes for the preparation of nitric ether are nitrous gas, ether, oil, acetic acid, oxalic acid, and carbonic acid gas.

If equal parts of nitric acid and alcohol are mixed together, a violent efferveſcence immediately takes place, which is owing to the evolution of a great quantity of gas, which being a compound of ether and nitrous gas, has been denominated *etheriſed nitrous gas*. The ſame gas is obtained by employing a diluted acid; but then the mixture requires the aſſiſtance of heat. This gas may be collected in veſſels over water. It has a diſagreeable ethereal odour, quite different from the odour of nitric ether, and exactly ſimilar to that kind of ether which is furniſhed by the oily, carbonated hydrogen gas, treated with oxymuriatic acid gas. If a candle be applied to this gas, it burns ſlowly with a yellow flame. This gas is ſoluble in water, and is wholly abſorbed; but the abſorption is ſlow. The water acquires the odour of the gas. Alcohol alſo diſſolves it completely, and more rapidly. Oxygen gas mixed with this gas, provided it be pure, produces no change; but when the mixture is ſet fire to, there is a violent detonation. When this gas was expoſed to ſulphuric, nitric, and muriatic acids, the ether was abſorbed by the acids, and the nitrous gas remained behind. The ſulphurous acid in the ſtate of gas, combined with an equal bulk of the inflammable gas, alſo decompoſed it; but this effect did not take place till after ſeveral days.*

* Jour. de Phyſ. xlv. p. 245.

If the alcohol and nitric acid be mixed together in the proportion of one of the former to three of the latter, and a gentle heat be applied, there is a copious evolution of gas, which is compoſed of the etheriſed nitrous gas and nitrous gas. If towards the end of the proceſs, when a ſmall part of the liquid remains in the retort, it be allowed to cool, cryſtals are formed; and theſe cryſtals are found to be oxalic acid. They were formerly called *cryſtals of Hierne*, from the name of a Swediſh chemiſt, who firſt diſcovered them *.

(s) Dr Black, we believe, contrived a ſpring for the ſtopper which kept down the cork till it was puſhed up by the elaſtic vapours; and when they had eſcaped, it returned to its place by the force of the ſpring.

If one part of nitric acid be added to its own weight of alcohol, and one part of ſulphuric acid be added ſoon after, the mixture is ſuddenly inflamed, and burns with great violence. In this caſe, when the products are collected, they are found to be ether and oil.

From this ſtatement of facts, therefore, it appears, that the production of nitric and ſulphuric ethers is nearly the ſame; that the differences which take place, are owing to the different nature of the acids; the violent action which follows in the formation of nitric ether, depending on the nitric acid itſelf being decompoſed, and by the operation of new affinities, new actions having taken place.

III. Of Muriatic Ether.

853 Proceſſes for obtaining it. 1. Muriatic acid has no ſenſible action on alcohol, either by ſimple mixture, or by diſtilling them together, as in the former caſe. Beaumè obtained a ſmall quantity of muriatic ether, by combining together muriatic acid and alcohol in the ſtate of vapour. But other means were thought of for this purpoſe, and particularly the oxymuriate of antimony, and the oxide of zinc diſſolved in muriatic acid, and to diſtil this ſalt, concentrated by evaporation, in cloſe veſſels with alcohol. By this proceſs muriatic ether has been obtained. But the moſt ſucceſsful method of procuring this ether, was propoſed by Courtanvaux. His proceſs is the following.

854 From ſalts of tin. 2. One part of alcohol is mixed with three parts of oxymuriate of tin, or the fuming liquor of Libavius, in a glaſs retort. A ſtrong heat is produced, with the production of a white ſuffocating vapour, which diſappears when the mixture is agitated. There is then emitted an agreeable odour, and the liquor aſſumes a lemon colour. The retort is then to be placed on a ſand bath; two receivers are to be attached, one of which is to be immerſed in cold water. There paſſes over at firſt ſome pure alcohol, and ſoon after the ether, which is known by its fragrant odour, and the ſtreams which run down the ſides of the retort. When the odour changes, and becomes ſharp and ſuffocating, the receiver muſt be changed; and if the diſtillation be continued, a clear acid liquor is procured, on the ſurface of which are obſerved ſome drops of ſweet oil, which is ſucceeded by a yellow matter of the conſiſtence of butter, which is a true muriate of tin, and at laſt a brown heavy liquid, which exhales very copious white vapours; and there remains in the retort a gray matter in the ſtate of powder.

855 Purification. 3. To purify this ether, it is put into a retort over carbonate of potaſh. A briſk efferveſcence takes place, and a very copious precipitate is produced. This is owing to the oxide of tin which the acid had carried off during the diſtillation. A little water is to be added, and diſtilled with a gentle heat. About the one-half of the product of the ether is thus obtained. All the fluids which come over after the muriatic ether, are loaded with oxide of tin; they attract moiſture from the air, and combine with the water without any precipitation.

856 Prepared from common ſalt. 4. Another method has been propoſed for the preparation of muriatic ether by Laplanche. He pours into a tubulated retort ſulphuric acid and alcohol on common ſalt which has been ſtrongly dried. The muriatic acid gas, diſengaged by the ſulphuric acid, meeting the vapours of the alcohol in the retort, combines with them. In this way an ether is obtained, which may be purified in the uſual way. But in this proceſs, Fourcroy thinks, that the production of ether is owing to a ſmall portion of oxymuriatic acid which is formed during the proceſs.

857 and manganeſe, 5. Pelletier has ſucceeded in obtaining muriatic ether, by diſtilling in a large tubulated retort, a mixture of oxide of manganeſe, common ſalt, concentrated ſulphuric acid, and alcohol. The quantity of ether obtained by this proceſs, is equal to one half the weight of the alcohol employed.

858 and oxymuriatic acid gas. 6. Another proceſs has been propoſed by Berthollet, by diſtilling with a gentle heat, alcohol which has been ſaturated with oxymuriatic acid gas, and by diſtilling the oxide of manganeſe, a mixture of alcohol, and ſtrongly concentrated muriatic acid.

859 Properties. 7. Muriatic ether thus obtained, is tranſparent and very volatile. It has nearly the ſame odour as ſulphuric ether. It burns like it, and gives out a ſimilar ſmoke; but it differs in two of its properties; the one is, that it exhales, while burning, an odour as pungent and acrid as ſulphurous acid; and the other is, that the taſte is aſtringent like that of alum. This difference in odour and taſte is owing, it is ſuppoſed, to ſome extraneous ſubſtances with which it is contaminated; for in the whole proceſs of its formation it appears to be exactly the ſame; a conſtant product of the decompoſition of alcohol, by whatever re-agent this is effected.

IV. Acetic Ether.

860 Preparation. 1. An ether has alſo been obtained by diſtilling a mixture of acetic acid and alcohol. This was the firſt proceſs which was employed in the production of this ether. It was diſcovered by the count de Lauraguais in 1759. It has been improved by Pelletier, who diſtilled equal quantities of acetic acid, obtained from acetate of copper, and alcohol. It was then poured back into the retort, and diſtilled a ſecond time. When this proceſs is finiſhed, it is diſtilled a third time, and the product of the third diſtillation is a mixture of acetic acid and ether. To ſeparate the acid from the ether, it is ſaturated with potaſh, and diſtilled with a gentle heat. The acetic ether paſſes over in a ſtate of purity.

2. Another proceſs has been propoſed to obtain the ſame ether. Take 16 parts of acetate of lead, ſix parts of concentrated ſulphuric acid, and nine parts of alcohol. Let it be diſtilled till ten parts come over. Let this liquid be agitated with one-third of its bulk of lime water; the ether ſeparates and ſwims on the top. The quantity generally amounts to about ſix parts.

3. This ether is ſimilar to the other ethers in its properties, excepting that it has a ſlight odour of acetic acid.

4. Ether has alſo been formed by ſeveral other acids, and it appears, that theſe acids poſſeſs one common property in their action on alcohol, for all the

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* Jour. de Phyſique, p. 346.

ethers produced by the different acids are nearly the ſame, and indeed it is ſuppoſed would be exactly the ſame, were it not that they are contaminated with extraneous matters derived from the acids, the alcohol, or other ſubſtances, which are employed in their formation.

Sect. III. *Of Fixed Oils.*

861 Oils of two kinds.

1. Oils, which are copious productions of nature, have been long known; and their extenſive utility in domeſtic economy and the arts, have always rendered them objects of great importance. The general characters of oils are combuſtibility, inſolubility in water, and fluidity. From the peculiar properties of different oils, they are naturally divided into two kinds; fixed or fat oils, and volatile or eſſential oils. The fixed or fat oils require a high temperature to raiſe them to the ſtate of vapour, a temperature above that of boiling water; but the volatile or eſſential oils are volatilized at the temperature of boiling water, and even at a lower one. Both the volatile and fixed oils are obtained from plants, and ſometimes from the ſame plant, but always from different parts of it. While the ſeeds yield fixed oil, the volatile oil is extracted from the bark or wood.

862 Found only in the ſeeds of vegetables.

2. One of the moſt diſtinguiſhing characteriſtics of the fixed oils is, that they exiſt only in one part of the vegetable. They are only found in the ſeeds. No trace of fixed oil can be detected in the roots, the ſtem, leaves or flowers of thoſe plants, whoſe ſeeds afford it in great abundance. The olive may ſeem an exception to this. The oil which it yields is extracted, not from the ſeed, but from its covering. Among plants too, fixed oils are only found exiſting in thoſe whoſe ſeeds have a peculiar ſtructure. The ſeeds of plants have ſometimes one lobe, in which caſe they are called *monocotyledonous* plants; and ſometimes they have two, when they are denominated *dicotyledonous*. The formation of fixed oil in plants is excluſively limited to the latter claſs. There is no inſtance of fixed oils being found in the ſeeds of plants which have only one lobe*. Thoſe ſeeds which yield the fixed oils, contain alſo a conſiderable portion of mucilage, ſo that when ſuch ſeeds are bruiſed and mixed with water, they form what is called an *emulſion*, which is a white fluid containing a quantity of the oil of the ſeed mixed with the mucilage. One of the moſt common emulſions, that of almonds, is an inſtance of this.

Fixed oils are extracted from the ſeeds of a great number of plants. Thoſe which yield it in greateſt abundance are, the olive, thence called *olive oil;* the ſeeds of lint, and the kernels of almonds, called *linſeed*, or *almond oil*. Fixed oils are alſo obtained from animals, ſuch as *train oil*, as it is called, which is extracted from the fat or blubber of the whale. Fixed oil is obtained alſo in great abundance from the liver of animals, and is found to exiſt in the eggs of fowls.

863 Have different properties.

3. Theſe different kinds of fixed oils, although they poſſeſs many common properties, yet in others they are very different. Many of the vegetable oils have no ſmell, and ſcarcely any perceptible taſte. The animal oils, on the contrary, are generally extremely nauſeous and offenſive. Theſe differences are ſuppoſed to be owing to the mixture of extraneous bodies, or to certain chemical changes which ariſe from the action of theſe bodies upon each other, or on the oil itſelf.

864 Preparation.

4. As the fixed oils exiſt ready formed in the ſeeds of plants, they are generally obtained by *expreſſion*, and hence they have been called *expreſſed oils*. This is done by reducing the ſeeds to a kind of pulp, or paſte, which is incloſed in bags, and ſubjected by means of machinery, when it is obtained in the large way, to ſtrong preſſure, ſo that the oil flows out, and is eaſily collected. The oil which is obtained by this proceſs, which has been called *cold drawn oil*, becauſe it is procured without the application of heat, and merely by preſſure, is the pureſt; but the quantity which ſeeds in general yield is comparatively ſmall, and ſome ſeeds which contain a conſiderable portion of oil, ſcarcely afford any when treated in this way. It therefore becomes neceſſary for extracting the oil from ſeeds of the latter deſcription, and to have it in greater abundance from all ſeeds, to employ heat, to facilitate the ſeparation of the oil from the mucilage or other matters with which it is combined. For this purpoſe heat is applied, either to the apparatus which is employed in preſſing out the oil, or the bruiſed ſeeds are expoſed to the vapour of water, and ſometimes they are boiled in the water itſelf, by which means thoſe ſubſtances which are ſoluble in water, are ſeparated, and thus the oily part which adhered to theſe ſubſtances, is diſengaged.

865 Purification.

5. The oils which are obtained in this way are very impure. They are mixed with mucilage, and other parts of the ſubſtances from which they have been extracted. Many of theſe matters ſeparate from the oils when they are left at reſt. They are ſometimes mechanically purified by filtration through coarſe cloths, by which means the groſſer parts are ſeparated. Different oils too, it is ſaid, undergo different kinds of purification by different manufacturers, but theſe proceſſes are kept ſecret. After they have remained at reſt for ſome time, they are filtered and agitated with water, by which the parts that are ſoluble in this fluid are ſeparated from the oil. Sometimes they are gently heated, for a ſhorter or longer time, according to the nature of the ſubſtances with which the oil is contaminated. Acids diluted with water are employed to ſeparate the mucilage; lime and the alkalies are alſo uſed to combine with an acid which holds this mucilage in ſolution, and thus to favour its precipitation. Alum, chalk, clay, and aſhes, are alſo employed in the purification of oils.

866 Properties.

6. Fixed oils are generally liquid, but of a thick, viſcid conſiſtence. They are mild or inſipid to the taſte; ſometimes, however, they have a peculiar taſte, which is analogous to that of the plant from which they have been extracted. When pure, they have no ſmell, but are ſometimes impregnated with the odour of the ſeed which produces them. The fixed oils are rarely quite colourleſs, but are generally green or yellowiſh. If they are green when freſh prepared, this colour changes to a yellow, and in time to an orange or red. Fixed oils in general are lighter than water. The ſpecific gravity varies from 0.9153, which is that of olive oil, to 0.9403, that of linſeed oil. The boiling point of the fixed oils is not under the temperature of

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* Fourcroy Connaiſſ. vii. 319.

Inflammable ſubſtances.

of 600°. When expoſed to cold, they congeal, and even cryſtallize. There is, however, a conſiderable variety in this reſpect, among fixed oils: ſome become ſolid at the temperature of a few degrees above the freezing point of water; while others, on the contrary, require a degree of cold =5°; and ſome remain fluid when expoſed to the greateſt cold. Thoſe oils, it has been obſerved, which moſt readily become ſolid, ſuch as olive oil, are leaſt ſubject to change; while thoſe which congeal with difficulty have a greater tendency to ſpoil and become rancid.

867 Action of heat.

7. When fixed oil is expoſed to heat, it does not evaporate, till it is raiſed to the temperature of boiling, or 600°; but when it is thus raiſed in vapour its properties are changed. It is decompoſed by the ſeparation of ſome of its principles. The part that is volatilized has a greater proportion of hydrogen; charcoal is depoſited, and water and ſebacic acid are formed, while carbonated hydrogen gas is diſengaged. By this diſtillation an oil was produced, denominated by the older chemiſts, *philoſophical oil.*

When oil is expoſed to the open air, and a burning body is brought in contact with it, it readily takes fire, and burns rapidly, with a yellowiſh white flame. It is on this converſion of oil into vapour, and the inflammation of this vapour, that the application of oil in lamps and candles depends. The oil is gradually, and in ſmall quantities, brought in contact with the burning part of the wick; it is converted into vapour, which is immediately inflamed, and continues to burn till new portions are ſupplied to undergo the ſame change, and thus keep up a conſtant and uniform light and heat.

868 Compoſition.

8. According to the analyſis of olive oil by Lavoiſier, it is compoſed of hydrogen and carbone. In the experiment which he inſtituted to aſcertain its component parts, he burnt

oil 15.79 grs. troy,
oxygen gas 50.86
66.65

The products of this combuſtion were water and carbonic acid. The weight of the water could not be aſcertained with much preciſion, but the quantity of carbonic acid which was formed, amounted to 44.50 grs. This quantity ſubtracted from the whole weight of the ſubſtances conſumed, namely the oil and oxygen gas, left 22.15 grs. for the weight of the water. The proportion of oxygen in this quantity of water is 18.82 grs. which leaves 3.33 grs of hydrogen, the other component part. The proportion of oxygen in 44.50 grs. carbonic acid gas is 32.04 grs. which leaves 12.46 of carbone. The oxygen of the water and of the carbonic acid, namely 18.82 grs. of the one, with 32.04 grs. of the other, make up the whole quantity of oxygen, namely 50.86 grs. that was conſumed. From this analyſis, therefore, 15.79 of olive oil are compoſed of

12.46 carbone,
3.33 hydrogen.
15.79.

The component parts, therefore, of 100 grains of olive oil are

78.92 carbone,
21.08 hydrogen.
10.000

869 Inſoluble in water.

9. The fixed oils are inſoluble in water. When it is neceſſary to combine them with this liquid, it is by means of mucilaginous ſubſtances, in which caſe the mixture is known under the name of *emulſion*, or with alkaline ſubſtances, when it is diſtinguiſhed by the name of ſoap.

870 Action of air.

10. When fixed oils are expoſed to the air, they undergo peculiar changes; and theſe changes are different, according to the nature of the oil.

11. Some of theſe oils become thick, opaque, white, granulated, and are analogous in appearance to tallow. Oils ſubject to this change are called *fat oils*, ſuch, for inſtance, is olive oil, almond oil, and rapeſeed oil. This change is more or leſs rapid in different circumſtances. If a thin layer of oil be ſpread on the ſurface of water, and expoſed to the air, it takes place in a few days, and this effect is owing to the abſorption of oxygen, which combines with the oil. It was ſuppoſed by Berthollet, that it depended on the action of light; but his experiments were repeated by Senebier, who found that olive oil when kept in the dark, became rancid, while the ſame kind of oil expoſed to the light, but excluded from the air, remained unchanged *.

12. But other oils, when they are expoſed to the air, dry altogether, yet have the property of retaining their tranſparency. Oils which have this peculiar property are called *drying oils*. The oil of poppies, hempſeed oil, and particularly linſeed oil, are poſſeſſed of this property. The nature of the change which takes place in theſe drying oils, is ſuppoſed to depend on the abſorption of oxygen; and this oxygen combining with the hydrogen of the oil forms water. This opinion is ſupported by the practice which is followed to increaſe the drying property of linſeed oil. It is uſually boiled with litharge, before it is employed by painters. The litharge in this caſe is partly reduced to the metallic ſtate, by being deprived of its oxygen, which is ſuppoſed to combine with the oil.

871 Drying oils.

872 Rancidity.

13. But many of the fixed oils, when expoſed to the air for a ſufficient length of time, undergo a farther change, and acquire very different properties. They are then ſaid to become *rancid*. During this change, they aſſume a brown colour, have the property of changing vegetable blues to red, and acquire a peculiar ſmell and taſte. In this change, the ſebacic acid is formed, which depends on a new combination of the hydrogen and carbone of the oil in certain proportions with the oxygen abſorbed from the atmoſphere. To this acid therefore, the rancidity of oils ſeems to be owing. Part of the hydrogen of the oil too, it would appear, combines with the oxygen and forms water †.

873 Action of charcoal.

14. Carbone in the ſtate of charcoal, has no action upon oils; but they are purified and rendered colourleſs by being paſſed through charcoal powder.

874 Of phoſphorus.

15. Phoſphorus combines with oils, with the aſſiſtance of heat. A ſmall portion of the phoſphorus is diſſolved,

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* Seneb. Ann. de Chim. xi. 91.

† Fourcroy Connaiſſ. Chim. vii. 328.

ſolved, which communicates a luminous property to the oils, ſo that when they are ſpread upon any ſurface, they ſhine in the dark. When the oil is completely ſaturated with the phoſphorus with the aſſiſtance of heat, and is allowed to cool, part of the phoſphorus is depoſited, and cryſtallized in tranſparent octahedrons. When this phoſphorated oil is diſtilled, phoſphorated hydrogen gas is diſengaged.

875 Of ſulphur. 16. Sulphur eaſily combines with fixed oil, with the aſſiſtance of heat. The ſolution which was formerly called *ruby of ſulphur*, is of a reddiſh colour. When it cools, the ſulphur cryſtallizes, by which proceſs Pelletier obtained ſulphur in the form of octahedrons. When the cooling is too rapid, the ſulphur is precipitated of a yellow colour, in the ſhape of needles. If this ſulphurated oil, which has a peculiarly fetid odour, be diſtilled, it affords a great quantity of ſulphurated hydrogen gas *.

876 Of acids. 17. The acids have a powerful effect on the fixed oils. The ſulphuric acid, when concentrated, decompoſes them. They become brown, thick, and at laſt of a black colour. Water is formed, charcoal is precipitated, and even an acid is formed. Nitric acid in the cold thickens fixed oils, by communicating part of its oxygen. In the ſtate of nitrous acid it produces a more violent action. There is a conſiderable efferveſcence, with the evolution of a great quantity of nitrous gas. If a mixture of nitrous acid and concentrated ſulphuric acid be thrown upon fixed oils, they inſtantly inflame, and leave behind a ſpongy maſs of charcoal. Muriatic acid has little effect on fixed oils, but the oxymuriatic acid thickens and bleaches them, in the ſame way as tallow or wax.

877 Uſes. 18. The various purpoſes to which fixed oils are applied, are too well known to require particular enumeration. They are employed in domeſtic economy, either as articles of food, and for this purpoſe are uſed alone, or in combination with other ſubſtances; or they are employed for giving light, by being burnt in lamps. They are uſed in medicine, either on account of the properties which peculiar oils poſſeſs, or on account of the properties they communicate to other ſubſtances with which they are combined. In this ſtate the uſe of oils is well known in the form of unguents, plaſters, and liniments. In the arts, fixed oils are of the moſt extenſive utility. They are employed in the fabrication of ſoaps, for mixing colours in painting, for ſome kinds of varniſh, and for defending ſubſtances from the action of air and moiſture †.

878 Affinities. 19. The order of the affinities of fixed oils is the following:

Lime,
Barytes,
Fixed alkalies,
Magneſia,
Ammonia,
Oxide of mercury,
Other metallic oxides,
Alumina.

Sect. IV. *Of Volatile Oils.*

879 Characters. 1. Volatile oils are diſtinguiſhed from the fixed oils by their volatility, fragrance, and acrid taſte. They are alſo known under the name of *aromatic oils*, from their odour; or *eſſential oils*, or ſimply *eſſences*, from being ſuppoſed to conſtitute the *eſſence* or the *exiſtence* of the vegetable matters which furniſh them.

880 Names.

881 Found in all parts of plants but the lobes of the ſeeds.

2. Volatile oils are not limited to particular parts of plants, but are found to exiſt in every part of the plant, excepting in the ſeed, which furniſhes the fixed oils. A great number of roots which are generally diſtinguiſhed by an aromatic odour, and have more or leſs of an acrid taſte, afford volatile oils. They are furniſhed alſo by many woods, ſuch as thoſe of the pine and fir tribe, and by many of thoſe which are natives of warm climates. The leaves of a great number of plants belonging to the didynamia claſs alſo afford volatile oil, as well as many of the umbelliferous plants. It is obtained alſo from many flowers of vegetables, and alſo from the covering of many fruits, as the ſkin of oranges and lemons. It is alſo obtained from a great number of ſeeds; but it is never found in the cotyledons or lobes themſelves, but only in the external covering. The quantity of volatile oil which is obtained from vegetables, varies according to the age, the ſoil in which they grow, and the ſtate of the plant. Some plants while green furniſh it in greateſt abundance, while others yield moſt when they are dry.

882 Preparation. 3. There are two proceſſes by which volatile oil may be obtained. When it exiſts in plants in great abundance, and in veſicles in a fluid ſtate, it may be ſeparated by mechanical means. Thus, by ſimple expreſſion, the volatile oils are extracted from many plants, as, for inſtance, from the fruit of the orange and the lemon. From the outer rind of theſe fruits, when they are freſh, the volatile oil is obtained in the liquid form; but in general, the volatile oils of plants are neither ſo abundant, nor do they exiſt in that ſtate of fluidity, by which they can be procured by ſo ſimple a proceſs. In moſt caſes they are ſubjected to the proceſs of diſtillation; and for this purpoſe they are macerated for ſome hours in water. They are then introduced into a ſtill along with the water; a moderate heat is applied and continued till the fluid boil, when a great quantity of vapour of water, mixed with the volatile oil, paſſes over, and is received in proper veſſels. The oil collects on the ſurface of the water, from which it may be eaſily ſeparated. The water itſelf is of a milky colour, on account of a ſmall quantity of oil ſuſpended in it; and even after the water becomes tranſparent by the particles of the oil ſeparating from it, and riſing to the top, it is ſtill loaded with the peculiar odour of the plant. This was ſuppoſed to be a ſeparate principle of vegetables, to which Boerhaave gave the name of *ſpiritus rector*, and which is ſtill known by the name of *aroma*. This fragrance of the water is owing to the ſolution of a certain portion of oil in it. In the diſtillation of the volatile oils, different practices are followed, according to the nature of the plant, and the proportion of the oil exiſting in it. The roots, wood, bark, fruits, dried plants, after being cut in pieces, raſped down or bruiſed, are macerated for ſome hours, or for ſome days, according to the ſolidity or particular ſtate of the vegetable matter. Freſh plants are diſtilled with the ſmalleſt quantity of water, have no need of previous maceration, and do not require ſo high a temperature.

883 Fragrance. 4. The volatile oils are particularly diſtinguiſhed by their fragrance, which varies in the oils extracted from

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* *Fourcroy Connaiſſ. Chim.* vii. 329.

† *Ibid.* vii. p. 330.

different plants. The conſiſtence of the volatile oils alſo varies conſiderably. Sometimes they are as fluid as water, which is the caſe with thoſe oils obtained by
884 Fluidity. expreſſion. Some are thick and viſcid, as thoſe generally are which are extracted from woods, roots, barks, and fruits of the warmer regions. Some congeal, or aſſume a granulated ſolid conſiſtence at different tem-
885 Cryſtals. peratures. Of theſe laſt, ſome are always found to be in the concrete ſtate. Several of the volatile oils are ſuſceptible of cryſtallization, depoſiting in the remaining portion of the oil which continues liquid, tranſparent polyhedrons, more or leſs of a yellow colour, which are found to be pure oil. This laſt change, Vauquelin thinks, is owing to an incipient oxidation; for it never takes place, unleſs oils have been kept for ſome time.

886 Colour. 5. There is great variety of colour among volatile oils. Some indeed are nearly colourleſs, as the oil of turpentine; but in general they are of different ſhades of colour. Some are yellow, as the oil of lavender; ſome are of a reddiſh yellow or brown, as the oil of cinnamon or of rhodium; ſome are blue, as the oil of chamomile; and ſome are green, as that of parſley. But the moſt prevailing colour among volatile oils is yellow or reddiſh.

887 Taſte. 6. Volatile oils have almoſt always an acrid, hot, and even burning taſte. It is obſerved that the moſt acrid vegetable matters do not yield an oil poſſeſſed of this quality. The ſpecific gravity of volatile oils is generally leſs than that of water. Some volatile oils, however, as thoſe of ſaſſafras and canella, have a greater ſpecific gravity. The ſpecific gravity of oils varies from 0.8697 to 0.9910, in thoſe which are lighter than water; but thoſe which are heavier are from 0.0363 to 1.4049.

888 Action of light. 7. When volatile oils are expoſed to the light, the colour becomes conſiderably deeper; they become thicker, and increaſe in ſpecific gravity. In ſpeaking of a ſimilar change which takes place in the fixed oils, this change was aſcribed to the abſorption of oxygen; but, according to the experiments and obſervations of M. Tingry, it is effected merely by the action of light; for in his experiments oxygen gas was entirely excluded.*

889 Of heat. 8. When volatile oils are expoſed to heat, they evaporate very readily. They are much more combuſtible than the fixed oils; and in burning give out a great quantity of ſmoke, a very bright white flame, and a good deal of heat. They require a greater proportion of oxygen than the fixed oils, and yield a greater quantity of water. This ariſes from a greater proportion of hydrogen, and a ſmaller quantity of carbone, which they contain.

890 Of air. 9. When volatile oils are expoſed to the open air, they undergo another change. They aſſume a deeper colour, and become viſcid, exhaling at the ſame time a very ſtrong odour. The air around is deprived of its oxygen; it combines with the hydrogen of the oil, and forms water, which is obſerved in drops on the ſurface. Many of the volatile oils when thus expoſed paſs into the reſinous ſtate, and are almoſt entirely deprived of their odour. This depends on the loſs of part of their hydrogen, and conſequently the increaſe of the proportion of carbone.

891 Of water. 10. The volatile oils are in ſome degree ſoluble in water. When they are agitated with this liquid, they combine with it, and communicate a very ſtrong odour, and a ſlightly acrid taſte.

892 Phoſphorus and ſulphur. 11. Phoſphorus and ſulphur are ſoluble in volatile oils. With phoſphorus the ſolution is luminous in the dark, is extremely fetid, and gives out, by the force of heat, phoſphorated hydrogen gas. The combination with ſulphur is known under the name of *balſam of ſulphur*. This gives out ſulphurated hydrogen gas on the application of heat.

893 Of acids. 12. The concentrated ſulphuric acid produces a brown colour, increaſes the viſcidity of the volatile oils, and diſengages part of their hydrogen with effervеſcence and heat. Part of the oil is decompoſed; charcoal is depoſited, and it contains an acid. Nitrous acid, when brought into contact with the volatile oils, produces inſtantaneous deflagration; converts them into water in a great meaſure, and carbonic acid; and there remains behind a voluminous maſs of charcoal. Muriatic acid has ſcarcely any action; but oxymuriatic acid renders them colourleſs, concrete in part, or viſcid, and brings them more nearly to the ſtate of reſins.

894 Uſes. 13. Some of theſe oils are employed in medicine. They are uſed alſo for the ſolution of thoſe ſubſtances which are to be employed as varniſhes; and many of them are uſed in perfumery.

895 Teſts of purity. 14. As many of the volatile oils are produced but in ſmall quantity, they are conſequently high priced. There is therefore ſome temptation to adulterate them with fixed oils, with cheaper volatile oils, or with other ſubſtances, to increaſe the quantity. It is therefore of ſome importance, to be able to detect ſuch frauds. When a volatile oil is adulterated with a fixed oil, there is a very eaſy teſt to diſcover it. Let a ſingle drop of the oil that is ſuſpected fall on clean paper, and expoſe it to a gentle heat. If the oil is pure, the whole will be evaporated, and no trace remain on the paper; but if it has been mixed with a fixed oil, a greaſy ſpot remains behind. Volatile oils are frequently adulterated with oil of turpentine; but this can only be detected by its peculiar odour, which continues for a longer time than moſt of the other volatile oils. When they are adulterated with alcohol, it is eaſily detected by mixing a little of the oil with water, which immediately produces a milkineſs, by the abſtraction of the alcohol from the oil, and its combination with the water.

896 Empyreumatic oils. 15. There is another claſs of oils known under the name of *empyreumatic oils*, which have different properties from thoſe which have been deſcribed. Theſe oils are acrid and ſtimulating, with a ſtrongly fetid and diſagreeable odour. It would appear, that theſe properties are owing to a partial decompoſition of other oils. Theſe oils are produced, as the name imports, by the action of fire. They are obtained when oils are forced to riſe in vapour, and paſs over in common diſtillation, with a greater degree of heat than that of boiling water, or by the application of a ſtrong heat to ſubſtances from which no oil was previouſly extracted. Theſe empyreumatic oils agree in ſome of their properties with the volatile oils. They combine in ſmall proportion with water, and they are ſoluble in alcohol; and probably any difference that exiſts between them, is owing to a partial decompoſition; for when they are

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* *Jour. de Phyſique*, xlvii. p. 169.

diſtilled, the oil is reſtored to a ſtate of purity, and the carbonaceous matter which had been ſeparated, remains behind.

Chap. XII. Of ALKALIES.

897 Origin of the name. THE word *alkali* is derived from the Arabian name of a plant, which affords the ſubſtance now diſtinguiſhed by that term. The name of the plant is kali, to which the Arabic particle *al* was added, expreſſive of the valuable qualities of the plant. When other ſubſtances were diſcovered, poſſeſſed of ſimilar properties, the meaning of the term was extended, and applied to ſuch matters as had ſeveral common properties. Three ſubſtances are generally ranked under the head of alkalies. Theſe are potaſh, ſoda, and ammonia. They are characterized by the following properties.

898 Characters. 1. They have a peculiar taſte, which is diſagreeably cauſtic, even when they are diluted with water.

2. They change vegetable blue colours to a green.

3. They have a ſtrong attraction for water, and combine with it in all proportions.

4. They have a ſtrong affinity for acids.

5. They melt in a moderate heat, but with a ſtronger heat they are volatilized.

899 Natural diviſion. The alkalies have been divided into two kinds, namely, the *fixed* and *volatile*. The two firſt, potaſh and ſoda, are denominated *fixed alkalies*, becauſe they require a great degree of heat to diſſipate or volatilize them. Ammonia has been called the *volatile alkali*, becauſe a very moderate degree of heat is ſufficient to volatilize it.

Fourcroy has claſſed two of the earths, namely, barytes and ſtrontites, under the head of alkalies. In ſome of their properties, theſe earths, no doubt, are analogous to the alkalies; but in other properties they are more cloſely allied to the earths. There ſeems, therefore, to be no inconvenience or ambiguity in claſſing them, as uſual, among earthy ſubſtances.

It may perhaps be conſidered as one of the general characters of the alkalies which we have now enumerated, that they have no action on oxygen, azotic, or hydrogen gaſes; nor is there any action between the alkalies and carbone.

Sect. I. *Of Potash and its Combinations.*

900 Names. 1. This ſubſtance has been long known in commerce, under many different names, derived from the ſubſtances from which it is extracted, or from the proceſſes by which it is prepared. The name of *aſh* or *aſhes* has been given to this ſubſtance, becauſe it is procured from the burnt aſhes of vegetables; and it has received the epithet of pot-aſhes, becauſe it is prepared in iron pots. It got the name of vegetable alkali, becauſe it was ſuppoſed that it only exiſted in vegetables. Being prepared from nitre and tartar, it was called the *alkali of nitre* or *tartar*, and the *ſalt of tartar*, a name which it ſtill retains in the ſhops. It has been propoſed alſo to diſtinguiſh it by the name of *kali*, the name of the plant from which it was originally procured.

901 Preparation. 2. Potaſh is generally prepared by burning wood or other vegetable matters, and thus reducing them to aſhes. The aſhes are then to be waſhed repeatedly with water, till the liquid comes off perfectly taſteleſs. If the liquid thus obtained be purified by filtration, and evaporated to dryneſs, a ſalt is obtained, which is the potaſh. In this ſtate it is contaminated with much extraneous matter; but if it be expoſed to a red heat, many of the foreign ſubſtances with which it is mixed, are diſſipated; it becomes whiter, and from its colour is then ſold under the name of *pearl-aſh*. This ſalt is prepared in great abundance in thoſe countries where wood abounds, as in North America and the north of Europe; and hence it is known in commerce under the name of *Ruſſian* or *American pearl-aſh*.

902 In this ſtate is impure. 3. Potaſh, in this ſtate, is conſidered as ſufficiently pure for the ordinary purpoſes of life to which it is applied; but it is ſtill mixed with much foreign matter, which renders it unfit for the purpoſes of the chemiſt. It has therefore always been conſidered as an object of great importance, to obtain it in a ſtate of purity.

But even when it is ſeemingly pure, by being deprived of all extraneous ſubſtances, it is found to poſſeſs very different properties, after being ſubjected to certain proceſſes. In one ſtate it is comparatively mild and inactive; in another, extremely acrid and corroſive. Various opinions were entertained of the cauſe of this remarkable difference, which it is unneceſſary to enumerate. 903 Black's diſcovery. The true cauſe was diſcovered and demonſtrated by Dr Black in the year 1756. This ingenious philoſopher, by a few ſimple and ſatisfactory experiments, clearly proved, that the different effects of the alkalies, lime, and magneſia, are owing to their combination with a peculiar ſubſtance, to which he gave the name of *fixed air*, becauſe it is fixed in theſe bodies. This fixed air, it has been already obſerved, is now known by the name of *carbonic acid*. When the alkalies are in combination with carbonic acid, they are in the mild ſtate; but when they are deprived of this acid, their effects being more powerful and corroſive, they are ſaid to be in the cauſtic ſtate.

When ſulphuric acid is poured upon a quantity of potaſh in its ordinary ſtate, a violent efferveſcence takes place. This, Dr Black proved, is owing to the eſcape of the carbonic acid in the ſtate of gas; for when the alkali is in its pure or cauſtic ſtate, no efferveſcence whatever takes place. He alſo proved, that the alkalies and lime in their mild ſtate, that is, when combined with carbonic acid, are heavier than in the cauſtic ſtate, and that this difference of weight is exactly equal to the quantity of carbonic acid which eſcapes. Since, then, theſe ſubſtances exhibit ſuch different properties in theſe two ſtates, it is neceſſary to procure them in a ſtate of purity, to examine their properties and effects. This is not without difficulty, on account of the ſtrong affinity which exiſts between the alkalies and carbonic acid; for although they are perfectly pure, as ſoon as they are expoſed to the air, they begin to attract the carbonic acid and return to their former mild ſtate.

904 Purification. 4. As this, therefore, is an object of importance, various proceſſes have been propoſed, to procure them as pure as poſſible. Some of theſe proceſſes we ſhall now detail.

905 Berthollet's proceſs. *a*. The following proceſs for the purification of potaſh is recommended by Berthollet. It is to be mixed

with double its weight of quicklime, with eight or ten times the weight of the whole mixture, of pure or rain water. Boil it for two or three hours in an iron veſſel; then let it remain in a cloſe veſſel for 48 hours, taking care to agitate it occaſionally. Let it afterwards be filtered, and boiled in a ſilver veſſel with a ſtrong heat, till it aſſume the conſiſtence of honey. Pour a quantity of alcohol upon it, equal in weight to $\frac{1}{3}$ of the alkali which has been employed; then put it on the fire, and let it boil for ſome minutes. Pour it afterwards into a bottle, and allow it to cool. The matter in the bottle ſeparates into three different ſtrata: at the bottom are depoſited ſolid bodies; in the middle there is an aqueous ſolution, or carbonate of potaſh; and on the top a liquor of a reddiſh brown colour, mixed with alcohol. Let this be carefully decanted off by means of a ſyphon. This is a ſolution of pure potaſh in alcohol. Put it into a baſon of ſilver, or of tinned copper; evaporate it rapidly, till a dry, black, and charry cruſt forms on the ſurface, and the liquor below, which has an oily appearance, becomes ſolid by cooling. Let the cruſt be removed, and pour the ſolution into porcelain veſſels. When it cools, it becomes ſolid. It is then to be broken in pieces, and put into cloſe veſſels. This is the potaſh in a ſtate of purity, not only freed from foreign matters, but alſo deprived of the carbonic acid.

Lime has a ſtronger affinity for carbonic acid than the potaſh. When, therefore, the lime deprived of its carbonic acid, as it is in the ſtate of quicklime, is brought into contact in ſufficient quantity with the potaſh, it deprives it of the carbonic acid. It is with this view that the lime is employed in this proceſs. The alcohol has the property of diſſolving potaſh, but has no action on the other ſubſtances with which it is combined. This is the reaſon why the alcohol, holding in ſolution the pure potaſh by its leſs ſpecific gravity, forms the upper ſtratum in the bottle. By the evaporation, the laſt ſtep of the proceſs, the alcohol and water are driven off, and the pure potaſh remains behind in the ſolid ſtate.

906
By Lowitz.

b. A more economical proceſs has been propoſed by Profeſſor Lowitz of Peterſburgh. He boils together the potaſh and quicklime, as in the former proceſs; filters the liquor, and evaporates, till a thick pellicle is formed on the ſurface. It is then ſet by to cool, till cryſtals are formed in it, which are cryſtals of extraneous ſalts, and are to be removed. He then continues the evaporation, and removes the pellicle as it forms on the ſurface during the proceſs. When the fluid ceaſes to boil and no more pellicle is formed, he removes it from the fire, and keeps conſtantly ſtirring it while it cools. He then diſſolves it in double the quantity of cold water, filters the ſolution, and evaporates in a glaſs retort, till regular cryſtals begin to be depoſited. If the maſs ſhould conſolidate ever ſo little by cooling, a ſmall quantity of water is to be added, and it muſt be heated again, to render it fluid. When a ſufficient quantity of regular cryſtals has been formed, he decants the liquid, which has a brown colour, and re-diſſolves the ſalt after it is ſuffered to drain, in the ſame quantity of water. The decanted liquor is preſerved in a well-cloſed bottle for ſeveral days, till it ſubſide and become clear. He then decants it, evaporates, and cryſtallizes a ſecond time, and repeats this proceſs as long as the cryſtals afford, with the leaſt poſſible quantity of water, ſolutions that are perfectly limpid. Theſe ſolutions are to be preſerved in well-cloſed bottles, to defend them from the acceſs of air *.

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By Klaproth.

c. The method of preparing pure potaſh by the indefatigable and accurate Klaproth, is ſomewhat different from this. We ſhall detail it in his own words. "As many perſons think that the preparation of a perfectly pure cauſtic ley is ſubject to more difficulties than it really is, I will here briefly ſtate my method of preparing it. I boil equal parts of purified ſalt of tartar, (carbonate of potaſh, or vegetable alkali prepared from tartar) and Carrara marble, burnt to lime, with a ſufficient quantity of water, in a poliſhed iron kettle; I ſtrain the ley through clean linen, and, though yet turbid, reduce it by boiling, till it contain about one half of its weight of cauſtic alkali; after which I paſs it once more through a linen cloth, and ſet it by in a glaſs bottle. After ſome days, when the ley has become clear of itſelf, by ſtanding, I carefully pour it off from the ſediment into another bottle. To convince myſelf of its purity, I ſaturate part of it with muriatic or nitric acid, evaporate it to dryneſs, and re-diſſolve it in water. If it be pure, no turbidneſs will take place in the ſolution. The quantity of cauſtic alkali which this ley contains, I aſcertain by evaporating a certain weighed portion of the ley to dryneſs, in an evaporating diſh of a known weight. I alſo take care in the preparation of this cauſtic ley, that the alkali be not entirely deprived of carbonic acid; becauſe, in that caſe, I can with greater certainty depend on the total abſence of diſſolved calcareous earth. By employing burnt marble, or, in its ſtead, burnt oyſter-ſhells, I avoid the uſual contamination of the cauſtic ley by aluminous earth; becauſe lime, prepared from the common ſpecies of lime-ſtone, is ſeldom entirely free from argil" *.

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Properties.

5. Potaſh thus obtained, is a white ſolid ſubſtance, which is ſuſceptible of cryſtallization, in long, compreſſed, quadrangular priſms, terminating in ſharp-pointed pyramids. Theſe cryſtals, which are only obtained from very concentrated ſolutions, are ſoft and deliqueſcent (T). The taſte is extremely acrid; and it is ſo corroſive, that it deſtroys the texture of the ſkin, the moment it touches it. It is from this property that it has derived the name of cauſtic; and in ſurgical language it has obtained the name of *potential cautery*, becauſe it is employed for the purpoſe of opening abſceſſes, or for deſtroying excreſcences. According to Haſſenfratz, the ſpecific gravity of potaſh is 1.7085. It converts vegetable blues into a green colour.

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Action of heat.

6. Light has no action on potaſh. When it is heated in cloſe veſſels, it becomes ſoft and liquid, and is afterwards converted into a white, opaque, and granulated maſs, when it cools. If the heat be increaſed

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* *Nicholſon's Journal*, 4to, vol. i. p. 164.

* *Analyt. Eſſays*, *Pref.* p. 8. *Tranſl.*

(T) By deliqueſcence is meant the melting of ſubſtances in the water which they attract from the air. Such ſalts are ſaid to be *deliqueſcent*.

to redneſs, it ſwells up, and riſes in vapour. If the veſſel be opened, there ariſes a white ſmoke, which is extremely acrid, and condenſes on cold bodies with which it comes in contact. But though it is thus ſublimed, it undergoes no other change than aſſuming a ſlight green colour.

7. There is no action between potaſh and oxygen or azotic gaſes, nor is there any direct action between potaſh and carbone. Phoſphorus and ſulphur enter into combination with potaſh, and form peculiar compounds, the nature of which we ſhall conſider, after having detailed the general properties of potaſh.

910 Of water.

8. Potaſh has a very ſtrong affinity for water. Water at the ordinary temperature diſſolves double its weight of potaſh. The ſolution, when the potaſh is pure, is colourleſs and tranſparent, and is nearly of the conſiſtence of oil.

911 Acids.

9. Potaſh combines readily with the acids, and forms compounds with them, having different properties, according to the nature of the acid which is employed.

912 Affinities.

Its affinities for the acids are in the following order:

Sulphuric,
Nitric,
Muriatic,
Phoſphoric,
Phoſphorous,
Fluoric,
Oxalic,
Tartaric,
Arſenic,
Succinic,
Citric,
Lactic,
Benzoic,
Sulphurous,
Acetic,
Saclactic,
Boracic,
Carbonic,
Pruſſic.

913 Uſes.

10. Potaſh is employed for a great variety of purpoſes; it enters into combination with many ſubſtances, and forms with them valuable and important compounds. It is employed in medicine as a uſeful and powerful remedy; in many arts and manufactures, as in bleaching, dyeing, and glaſs-making.

914 A ſimple ſubſtance.

11. Potaſh is to be conſidered as a ſimple ſubſtance. No attempts yet made have ſucceeded in decompoſing it. But although not the ſlighteſt proof has been adduced of its formation or decompoſition, it is conſidered by ſome as a compound ſubſtance. This opinion is founded on the analogy of its properties with ammonia; the compoſition of which has been fully demonſtrated. According to ſome, it is compoſed of lime and azote; and, according to others, of hydrogen and lime; but all theſe are mere conjectures, which have probably had their origin in that eagerneſs of the human mind, which leads it to fancy what it wiſhes to be true.

12. But we ſhall now conſider more particularly the action of the different ſubſtances which have been already treated of, on potaſh, and the different combinations which it forms with them.

I. Action of Phoſphorus on Potaſh.

915 Phoſphorated hydrogen gas.

1. There is no direct combination between potaſh and phoſphorus; but although theſe two bodies have little tendency to unite, they have a very powerful effect upon each other when they are heated together with water. It was in this way that Gengembre firſt obtained the ſingular gas, which has been already deſcribed, when treating of phoſphorus, under the name of *phoſphorated hydrogen gas*.

916 Proceſs for obtaining it.

2. If one part of phoſphorus and ten parts of a concentrated ſolution of pure potaſh be introduced into a ſmall retort, and expoſed to heat till it boils, phoſphorated hydrogen gas will paſs over, which may be received in jars over water: or if the beak of the retort be kept under the ſurface of water, the bubbles of the gas, as they riſe to the ſurface, explode, and form the beautiful coronet of white ſmoke, formerly mentioned. In making this experiment, the retort ſhould not be larger than to hold the ſolution, or, it ſhould be filled with hydrogen or azotic gaſes, in which the phoſphorated hydrogen gas will not inflame and explode, with the riſk of breaking the veſſel; for the inflammation can only take place when it comes in contact with the oxygen of the atmoſphere.

917 Nature of the proceſs.

3. In this proceſs, the water which holds the potaſh in ſolution, is decompoſed. The oxygen combines with part of the phoſphorus, and forms phoſphoric acid, while another part of the phoſphorus unites with the hydrogen, and paſſes over in the form of phoſphorated hydrogen gas. Thus, without any perceptible action between the phoſphorus and the potaſh, the decompoſition of the water is aided by means of the potaſh, in conſequence of its attraction for the phoſphorus, combined with the oxygen in the ſtate of phoſphoric acid. For it is found, that a quantity of phoſphate of potaſh is formed, correſponding to that of the phoſphorated hydrogen gas which is obtained. The decompoſition is alſo aſſiſted by the affinity of the phoſphorus for the oxygen and hydrogen of the water. The whole of the phoſphorated hydrogen gas which is formed, being diſengaged, ſhews that no combination takes place between it and the potaſh *.

II. Action of Sulphur on Potaſh.

1. Sulphur and potaſh very readily combine together. If one part of potaſh and three of ſulphur be triturated together in a glaſs or porcelain mortar, the mixture becomes hot, the ſulphur loſes its yellow colour, and acquires a greeniſh tinge. There is diſengaged a fetid ſmell of garlic; the mixture attracts moiſture from the air, becomes ſoft, and is almoſt entirely ſoluble in water.

918 Sulphuret of potaſh.

If two parts of potaſh and one of ſulphur be well mixed together, and heated in a crucible, the mixture fuſes; and by this proceſs is obtained *ſulphuret of potaſh* in the dry ſtate. This was formerly called *hepar ſulphuris*, or *liver of ſulphur*, from its reſemblance to the liver of animals. The ſame ſubſtance may be obtained by treating ſulphur with the potaſh of commerce, with this precaution, not to apply too ſtrong a heat, to occaſion a ſublimation of the ſulphur, and the too rapid evolution of the carbonic acid from the potaſh. When the fuſion is completed, it is poured out on a marble ſlab; it is covered up from the air, allowed to cool, and broken into ſmall pieces, to be inſtantly put up in well-cloſed glaſs veſſels.

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* *Fourcroy Connaiſs. Chim.* tom. ii. p. 202.

919 Properties. 2. The ſolid ſulphuret of potaſh, thus prepared, is of a ſhining brown colour like that of the liver of animals, from which it derived its former name. Expoſed to the air it becomes green, then paſſes to gray, and even to white. It is denſe, ſmooth, and has a vitreous fracture. It has no other ſmell than that of heated or ſublimed ſulphur; is acrid, cauſtic, and bitter to the taſte, and leaves a brown ſpot on the ſkin. With a ſtrong heat, in a porcelain retort, the ſulphur is ſublimed, and the potaſh remains in a ſtate of purity at the bottom of the veſſel. The ſulphuret of potaſh converts vegetable blue colours to green, and afterwards deſtroys them.

920 Hydro-ſulphuret. 3. But the ſulphuret of potaſh poſſeſſes theſe properties, only while it is recently prepared, and very pure. When expoſed to the air, it is readily decompoſed, and more ſo, as the air is loaded with moiſture. It abſorbs water with avidity, acquires a green colour, and exhales the fetid odour of ſulphurated hydrogen gas. This change is owing to the decompoſition of the water which has been abſorbed. Part of the ſulphur combines with the hydrogen, and forms ſulphurated hydrogen gas, which combines with the ſulphuret, and forms hydrogenated ſulphuret of potaſh.

921 Obtained by another proceſs. 4. This may alſo be formed by paſſing the ſulphurated hydrogen gas into a ſolution of potaſh. The gas is abſorbed and condenſed, till the potaſh is fully ſaturated. To this ſubſtance Berthollet, who particularly inveſtigated the nature of theſe compounds, gave the name of *hydro-ſulphuret of potaſh*.

922 Properties. This compound cryſtallizes, and is more permanent than the ſulphuret. The cryſtals are tranſparent and colourleſs, while thoſe of the ſulphuret are brown and opaque. The cryſtals are large and in the form of four-ſided priſms, terminating in four-ſided pyramids. It is decompoſed by heat, and by the action of the acids. Sulphurated hydrogen gas is diſengaged, but there is no depoſition of ſulphur. The oxymuriatic acid decompoſes the ſulphurated hydrogen, and then ſulphur is precipitated. The pure hydro-ſulphuret has no ſmell, when it has no addition of ſulphur beyond the ſaturation of the hydrogen. The alkali ſeems to have a ſtronger affinity for the ſulphurated hydrogen than for the ſulphur, ſo that when it is ſaturated with the firſt, that is, in the ſtate of hydro-ſulphuret of potaſh, which is in the form of cryſtals, and without ſmell or inodorous, it combines with no more ſulphur; but when ſulphurated hydrogen gas is made to paſs into a ſolution of the ſulphuret of potaſh already hydrogenated by its ſolution in water to a certain degree of ſaturation, the ſulphurated hydrogen acts in the manner of acids, precipitates the ſulphur like them, renders the liquid colourleſs, and leaves behind nothing but the hydro-ſulphuret of potaſh *.

923 Hydrogenated ſulphuret. 5. Sulphur combines with the latter compound, and forms a new compound, which may be obtained by pouring a liquid hydroſulphuret upon ſulphur. The ſulphur is diſſolved without the aſſiſtance of heat; the liquid aſſumes a darker colour, and then it is converted into the *hydrogenated ſulphuret*. Hydrogenated ſulphuret of potaſh is prepared by boiling together a mixture of pure potaſh and ſulphur in water. This ſolution is of a deep greeniſh yellow colour, has a very acrid bitter taſte, and a powerful action on many ſubſtances. It readily abſorbs oxygen when expoſed to the air. When it is kept in cloſe veſſels, ſulphur is depoſited; the liquid becomes tranſparent, and the ſmell is diſſipated. Thus, there are three different compounds of ſulphur with potaſh; namely, ſulphuret of potaſh, hydroſulphuret of potaſh, and hydrogenated ſulphuret, which are all diſtinguiſhed by peculiar properties.

III. Compounds of Potaſh with Acids, or Neutral Salts.

1. Sulphate of Potaſh (u).

924 Names. 1. This ſalt, which was one of the moſt early known, is a compound of ſulphuric acid and potaſh. It has been diſtinguiſhed by a great variety of names, as *ſal de duobus*, *ſal polychreſtus*, or ſalt of many virtues, *arcanum duplicatum*, and more lately *vitriolated tartar*, till in the new nomenclature it received the name of *ſulphate of potaſh*.

925 Preparation. 2. It is prepared by different proceſſes, either by directly combining the ſulphuric acid with the potaſh, and evaporating and cryſtallizing it; or by decompoſing other ſalts which have potaſh for their baſe, by means of the ſulphuric acid, which having a ſtronger affinity for the potaſh, combines with it and forms the new compound.

926 Properties. 3. The ſulphate of potaſh cryſtallizes in hexaëdral priſms, terminated by ſix-ſided pyramids; but this form is ſuſceptible of ſeveral varieties. It has a diſagreeable bitter taſte, it is not very hard, and may be eaſily reduced to powder. The ſpecific gravity is 2.4073. At the temperature of 60°, it is ſoluble in 16 times its weight of water; boiling water diſſolves about one-fifth part; on cooling it cryſtallizes in a confuſed maſs; and it is only by ſlow ſpontaneous evaporation that regular cryſtals can be obtained.

927 Action of heat. 4. It ſuffers no change by the action of the air. When placed upon burning coals, it decrepitates, and loſes its water of cryſtallization. At a greater heat it melts, and is converted into a kind of enamel as it cools.

5. When this ſalt is expoſed to a red heat, along with hydrogen gas or carbone, it is decompoſed, and converted into a hydrogenated or carbonated ſulphuret of potaſh.

6. The ſulphuric acid, with the aſſiſtance of heat, combines with the ſalt, and forms another with exceſs of acid. It undergoes a partial decompoſition by the action

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* Fourcroy Connaiſs. Chim. tom. ii. p. 206.

(u) The compounds of acids with any baſe are known by this name in the preſent chemical nomenclature; and when the acid has its greateſt proportion of oxygen, as in this caſe the ſulphuric acid, the name of the compound terminates in the ſyllable *ate*, as ſulphate of potaſh, nitrate of potaſh; but when the acid has its ſmaller proportion of oxygen, the name of the compound terminates in *ite*; as ſulphite of potaſh, nitrite of potaſh.

tion of nitric acid. The nitric acid combines with nearly $\frac{1}{3}$ of the potaſh, which is owing to the action of double affinity. The nitric acid combines with one part of the potaſh, while the ſulphuric acid unites with the ſulphate of potaſh, and forms a ſalt with exceſs of acid. A ſimiliar decompoſition takes place by means of the muriatic acid.

928 Compoſition. 7. The component parts of ſulphate of potaſh are, according to

	Bergman,		Kirwan.
Acid	40	-	45.2
Potaſh	52	-	54.8
Water	8	-	00.0
	100		100

929 Names. *Acidulous ſulphate of potaſh*, or *ſuper-ſulphate of potaſh*.—1. This ſalt was formerly called *vitriolated tartar with exceſs of acid.* It is prepared by heating together, in a retort, three parts of the ſulphate of potaſh, with one part of its weight of concentrated ſulphuric acid.

930 Properties. 2. It cryſtallizes in long flexible, ſhining cryſtals, and ſometimes it exhibits the form of ſix-ſided priſms. It has a ſharp, acrid, and hot taſte. It reddens vegetable blues. 931 Action of water. Expoſed to the air it becomes a little more opaque, but without any other change. It is more ſoluble in water than the ſulphate of potaſh, requiring only 2 parts of water at 60°, and diſſolves in leſs than 932 Of heat. its own weight of boiling water. It melts very readily, and has the appearance of a thick oil. When it cools, it becomes a white, opaque maſs, exhibiting on its ſurface ſhining ſilky cryſtals. When expoſed to a great heat, the exceſs of acid is driven off, and it is converted into the ſulphate of potaſh.

933 Hydrogen. 3. It is readily decompoſed by the action of hydrogen and of red-hot charcoal, which deprive it of a great portion of the ſulphur; and by ſulphur itſelf, which carries off the exceſs of ſulphuric acid in the form of ſulphurous acid.

4. The firſt of theſe ſalts, the ſulphate of potaſh, is employed in medicine as a purgative; the laſt has been applied to no uſe whatever.

2. Sulphite of Potaſh.

934 Names and preparation. 1. This ſalt was long known under the name of the *ſulphurous ſalt of Stahl.* It is a compound of the ſulphurous acid and potaſh. Its nature and properties have been particularly inveſtigated by Berthollet, Fourcroy, and Vauquelin. It may be formed by paſſing a current of ſulphurous acid gas into a ſolution of carbonate of potaſh in three times its weight of diſtilled water, till the effervеſcence ceaſes. The liquor becomes tranſparent and hot, and as it cools, the ſulphite of potaſh is depoſited in cryſtals.

935 Properties. 3. This ſalt is in the form of long, ſmall needles, diverging from a centre, or in rhomboidal plates, or in dodecahedrons formed by two tetrahedral pyramids, united and truncated very near the baſe. The cryſtals are white and tranſparent, but ſometimes of a ſlight yellow colour. The taſte is acrid and ſulphureous. 936 Action of the air. The ſpecific gravity is 1.586. The ſulphite of potaſh, expoſed to the air, very readily effloreſces (U); becomes white and opaque, and is converted into ſulphate of potaſh. This is owing to the ſulphurous acid abſtracting oxygen from the air, and becoming ſulphuric acid. It is very ſoluble in water, at the temperature of the atmoſphere, and much more ſo in boiling water. When this ſolution is expoſed to the air, it is ſoon covered with a thick pellicle, which falls to the bottom, and is afterwards replaced by another. This is the ſulphate of potaſh, which is formed in contact with the air. The oxymuriatic acid gas combined with this ſolution, forms almoſt immediately ſhining cryſtals of the ſulphate of potaſh.

937 Of charcoal. 3. Charcoal heated with this ſalt in a retort, yields ſulphurated hydrogen gas, and carbonic acid; and there remains in the retort, a hydrogenated ſulphuret of potaſh.

3. Nitrate of Potaſh.

938 Conſtituent parts and names. 1. This ſalt is compoſed of nitric acid and potaſh, and is well known under the names of *ſaltpetre* and *nitre*. It has alſo been denominated *ſalt of nitre*, *nitre of potaſh*, or *nitrated potaſh*. It is one of the moſt important of the ſalts, not only on account of the attention which it has excited, in tracing its formation, and ſtudying its nature and compoſition, but alſo on account of its numerous and valuable applications in domeſtic economy and in the arts.

939 Found in many plants. 2. The nitrate of potaſh exiſts ready formed in many plants, as in tobacco, borage, bugloſs, pellitory. It has been obſerved cryſtallized in needles in their dried ſtalks. According to ſome, it has been abſorbed by the vegetable from the ſoil in which it grows, while others ſuppoſe that it is formed within the plant, from the elementary principles.

Nitre exiſts in great abundance on the ſurface of the earth in different parts of the world, eſpecially in the warmer regions, as in India, Egypt, and South America. But the production of nitre is not limited to 940 Prepared artificially. theſe countries. It is produced artificially in Germany and France, by means of what are called *nitre beds*. Theſe are formed by collecting together the refuſe of animal and vegetable matters, in which the putrefactive proceſs is going on. They are mixed with earthy ſubſtances, but chiefly with calcareous earth, ſuch as the rubbiſh from buildings, or collections of the ſoil in which lime abounds. All that is neceſſary to favour the formation of the nitre, is to moiſten occaſionally with water the mixture of the animal, vegetable, and earthy matters; to expoſe it to a moderate temperature, and to defend it from rains, which would carry off the ſalt as it is formed. This artificial production of nitre was greatly improved and extended by the French during the late war, when they were preclud-ed

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(U) A ſalt is ſaid to effloreſce, when deprived of its water of cryſtallization in the ordinary temperature of the atmoſphere. A powdery cruſt is firſt formed on the ſurface; and as the proceſs goes on, the whole falls down into powder. The term *effloreſcence* is oppoſed to *deliqueſcence*, by which the deliqueſcent ſubſtance attracts moiſture from the air.

ed from the uſual ſupply of this ſalt from India. It is now produced, it is ſaid, in great abundance in France.

The nature of the proceſs, and the change which takes place in this artificial production of nitre, will be underſtood by conſidering its component parts. The conſtituent parts of the nitric acid are azote and oxygen. The oxygen is furniſhed by the air; and unleſs there is a ſupply of air, no change takes place. A great quantity of azotic gas is given out by animal matters during the putrefactive proceſs. But although theſe ſubſtances, when brought into contact with each other, do not combine to form nitric acid, it has been found by experiment, that azote, in its naſcent ſtate, or in the moment of evolution, enters into union with oxygen, and forms nitric acid, while the nitric acid thus formed combines with the potaſh which is furniſhed by the ſoil, or the vegetable matters.

941 Purification.

3. After the nitre is formed, it is mixed with water, which is evaporated, and a ſalt is obtained of a brown colour, which is called *crude nitre*. This is a mixture of ſeveral ſalts, and from theſe the pure nitre is ſeparated by other proceſſes. When it is ſufficiently purified, it is obtained in cryſtals of ſix-ſided priſms, terminating in ſix-ſided pyramids. The primitive form of its cryſtals is a rectangular octahedron, in which two faces of a pyramid are inclined to the other pyramid at an angle of 120°, and the two others at an angle of 111°. The form of the integrant molecule is the tetrahedron; but there are conſiderable varieties in the cryſtals of this ſalt, according as it is ſlowly or more rapidly evaporated.

942 Properties.

4. This ſalt is diſtinguiſhed by a cool, ſharp, and bitteriſh taſte. It is very brittle. When nitre in large cryſtals is reduced to powder, it is found to be a little humid; but that which is in the form of a white, opaque, irregular maſs, yields a dry powder, on which account it is generally preferred for many purpoſes, particularly in the manufacture of gunpowder. The ſpecific gravity of nitre is 1.9369. It is not altered by expoſure to the air. At the temperature of 60° it diſſolves in ſeven times its weight of water, and during the ſolution, a great degree of cold is produced. Boiling water diſſolves twice its weight of this ſalt.

943 Action of heat.

5. When the nitrate of potaſh is expoſed to heat, it fuſes before it becomes red, and is converted into a liquid of an oily conſiſtence. It loſes but very little of its water of cryſtallization, and if it be allowed to cool, it congeals into an opaque maſs with a vitreous fracture, which is known by the name of *mineral cryſtal*. While it is melted, it undergoes no change; but when the temperature neceſſary for ſimple fuſion is increaſed, it gives out oxygen gas to the amount of about $\frac{1}{8}$ of its weight. Towards the end of the proceſs, azotic gas is evolved, and the potaſh remains behind pure, ſo that the ſalt has been completely decompoſed. But to effect this decompoſition, a very ſtrong heat is neceſſary. When only part of the gas is extracted, the nitrate of potaſh is converted into the *nitrite*.

944 Of charcoal.

6. When nitre is mixed with charcoal in the proportion of three parts of the former to one of the latter, a violent inflammation takes place, either by expoſing the mixture to a red heat, or by bringing it into a contact with a burning body. Or the mixture may be projected into a red-hot crucible, when a deflagration or detonation takes place, and when the reſiduum in the crucible is examined, it is found to be potaſh partly united with carbonic acid, or the carbonate of potaſh. This was formerly called *nitre fixed by charcoal*, or an *extemporaneous alkali of nitre*. The deflagration in this caſe is owing to the combuſtible matter, the charcoal, coming in contact with the oxygen which is evolved by the nitre, expoſed to a high temperature. In another proceſs, this experiment was performed in cloſe veſſels, to collect the elaſtic fluids which are diſengaged; and beſides the carbonic acid gas which is formed by the union of the carbone and oxygen, and the azotic gas diſengaged by the decompoſition of the nitre, a ſmall quantity of water was found in the veſſels. To this product the alchemiſts gave the name of *clyſſus*, and aſcribed to it very wonderful properties in the preparation of the philoſopher's ſtone.

945 Of phoſphorus.

7. A violent deflagration alſo takes place when phoſphorus and nitre are treated in the ſame way. But this experiment ſhould be performed with very ſmall quantities, and with great caution. A mixture of nitre and phoſphorus ſtruck ſmartly with a hammer, produces a very violent detonation.

946 Of ſulphur.

8. When ſulphur is combined with three times its weight of nitre, it burns with great rapidity. This preparation was formerly made by detonating the two ſubſtances in a red-hot crucible. The product is ſulphate of potaſh, known by the name of *ſal polychreſt of Glaſer*. The ſulphur combines with the oxygen of the nitric acid, and forms ſulphuric acid, which enters into combination with the potaſh.

947 Gunpowder.

9. But one of the moſt important combinations of nitre is with charcoal and ſulphur, in the formation of gunpowder. This ſubſtance was firſt known in Europe in the 14th century. It is ſaid that it was known to the Chineſe much earlier. The proportions of the materials which enter into the compoſition of gunpowder are,

Nitre	76
Charcoal	15
Sulphur	9
	100

948 Preparation.

The materials are firſt reduced to a fine powder ſeparately. They are then carefully mixed together, and formed into a paſte with a little water. When the paſte has dried a little, it is forced through a ſieve, by which means it is reduced to grains of ſuch a ſize as may be wanted. The powder is then dried in the air, or in the ſun; and, after being dried, it is put into barrels which turn round by means of machinery, and thus by the friction of the grains of powder againſt the ſides of the barrel and againſt each other, it is poliſhed. This is called *glazing* the powder.

949 Nature of its action.

10. The theory of the combuſtion, and terrible effects of gunpowder is thus explained. The ſulphur and the charcoal burn with great rapidity by the addition of the nitre with which they are intimately mixed. During the combuſtion carbonic acid gas, azotic gas, ſulphurous acid gas, and according to ſome, ſulphurated hydrogen gas, are formed. Water and ammonia alſo are ſaid to be produced *. But according to Mr Cruickſhank, the quantity of water formed is not perceptible. The ſubſtances which remain after the deflagration are, carbonate of potaſh, ſulphate and

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* Fourcroy Connaiſs. Chim. iii. 122.

ſulphuret of potaſh, and ſome charcoal. It is obvious, that the irreſiſtible effects of gunpowder are owing to the ſudden evolution and expanſive force of the elaſtic fluids which are formed and diſengaged.

950 Fulminating powder.

11. Another combination of nitre produces effects ſtill more terrible. When three parts of nitre, two parts of potaſh, and one of ſulphur, are previouſly well dried and mixed together by trituration, they form a compound which is known by the name of *fulminating powder*. A few grains of this mixture expoſed to heat in an iron ladle firſt melt, aſſuming a darker colour; and when the whole is in fuſion, there is a violent exploſion. The heat ſhould be applied ſlowly and gradually, till it is completely fluid, and then by bringing it nearer the heat, the full effect of the exploſion is obtained. This combuſtion and exploſion are alſo owing to the inſtantaneous evolution of elaſtic fluids. The potaſh unites with the ſulphur, and forms a ſulphuret, which, with the aſſiſtance of the nitre, is converted into ſulphurated hydrogen. At a certain temperature the ſulphurated hydrogen gas is diſengaged, along with the oxygen gas of the nitre, and ſuddenly taking fire, ſtrikes the air by the exploſion which accompanies the evolution of the gaſes. When the mixture is made with equal parts of nitre and ſolid ſulphuret of potaſh, the detonation is more rapid, but the exploſion is leſs violent. 951 Powder of fuſion. With three parts of nitre, one of ſulphur, and one of ſawduſt, well mixed together, what is called *powder of fuſion* is formed. If a little of this powder is put into a walnut ſhell, with a thin plate of copper rolled up, and the mixture ſet fire to, it detonates rapidly, and reduces the metal to a ſulphuret, without any injury to the ſhell.

952 Fluxes.

12. A mixture of equal parts of nitre and tartar detonated in a crucible, gives a product which is much employed in metallurgy. This compound, called *white flux*, is a mixture of pure potaſh with the carbonate. When one part of nitre and two of tartar are treated in the ſame manner, the product obtained is a mixture of potaſh and charcoal. From its black colour, it is known under the name of *black flux*. This alſo is employed for a ſimilar purpoſe.

953 Compoſition.

13. Nitrate of potaſh, according to Bergman, is compoſed of

31 acid,
61 potaſh,
8 water.

100

According to Kirwan, it is compoſed of

44 acid,
51.8 potaſh,
4.2 water.

100.0

954 Uſes.

14. Nitre is not only employed for the purpoſes already mentioned, but it is uſed in medicine as a cooling remedy in feveriſh diſorders, and as a diuretic in urinary affections. It is employed alſo in many arts, as in dyeing, and in domeſtic economy, for the preſervation of animal matters, which are to be uſed as food. To theſe ſubſtances it imparts a red colour. From nitre, nitric acid is obtained, by decompoſing it by means of ſulphuric acid. Nitre it alſo employed to burn along with ſulphur in the formation of ſulphuric acid.

4. Nitrite of Potaſh.

1. This ſalt cannot be formed by direct combination of the nitrous acid with potaſh; but if a quantity of nitre be expoſed for ſome time in a crucible or retort, to a ſtrong heat, it becomes deliqueſcent and acid. It changes the blue colours of vegetables into green, attracts moiſture from the air, detonates feebly with combuſtible ſubſtances, and gives red thick vapours by the action of ſulphuric, nitric, muriatic, phoſphoric, and fluoric acids. This is the nitrite of potaſh, which is decompoſed by theſe acids, and gives out the red fumes of nitrous acid. Little more is known of the nature of this ſalt, with regard to its form, ſolubility, affinities, or proportion of its conſtituent parts.

5. Muriate of Potaſh.

955 Names.

1. This ſalt was formerly known by the name *febrifuge ſalt of Sylvius*. It was afterwards called *digeſtive ſalt*, *regenerated ſea ſalt*, and by Bergman *ſalited vegetable alkali*.

2. It is prepared by the direct combination of muriatic acid and potaſh. The ſolution is evaporated till a pellicle appears, when it is ſet by to cryſtallize.

956 Properties.

3. The cryſtals are in the form of regular cubes, or rectangular parallelopipeds. It has a diſagreeable bitter taſte, and by this is eaſily diſtinguiſhed from muriate of ſoda or common ſalt. The ſpecific gravity of this ſalt is 1.836. When the air is moiſt, it deliqueſces; but when the air is dry, it parts with its moiſture. Three parts of cold water are ſufficient for its ſolution. Boiling water diſſolves a little more, but regular cryſtals cannot be obtained by cooling. The ſolution muſt be left to ſlow ſpontaneous evaporation.

957 Action of heat.

4. When the muriate of potaſh is expoſed to heat, it decrepitates, loſes its cryſtalline form, and falls into powder by the ſeparation of .08 parts of its weight of water. When it acquires a red heat, it melts; if the temperature be elevated, it is ſublimed in the form of white vapour, unchanged. After complete fuſion, if it is allowed to cool ſuddenly, it becomes ſolid, and divides on the ſurface, into many ſmall plates of a ſquare form.

5. This ſalt is decompoſed by means of the ſulphuric and nitric acids. The firſt diſengages the muriatic acid with efferveſcence in the gaſeous form. By the action of the nitric acid the muriatic acid is converted into the oxymuriatic by combining with the oxygen of the nitric acid. With one part of nitric acid and two parts of muriate of potaſh, a compound of the two acids is formed, which was formerly employed in the ſolution of gold. This is a *nitro-muriatic acid*, or *aqua regia*.

958 Uſes.

6. This ſalt is no longer employed in medicine. It is recommended to be uſed for the decompoſition of nitrate of lime in the mother waters of nitre, to obtain the nitrate of potaſh, and alſo for procuring the cryſtallization of alum.

6. Hyper-oxymuriate of Potaſh.

959 Diſcovery and hiſtory.

1. This ſingular ſalt was the firſt known of all the combinations with the acid in this ſtate. Fourcroy

mentions, that Dr Higgins prepared this ſalt, which he calls *nitre*, by paſſing the oxymuriatic acid gas into a ſolution of potaſh; but he ſeems to have paid no farther attention to it, except obſerving, that it detonated on red-hot coals (x). It was firſt formed, and its nature and properties were firſt inveſtigated, by Berthollet. And ſince its diſcovery, it has been particularly examined by Lavoiſier, Dolfuz, Vanmons, Fourcroy, and Vauquelin, on the continent, and in England by Hoyle and Chenevix. The method of preparing this ſalt has been already deſcribed (at N° 556, p. 520.) in treating of hyperoxymuriatic acid. After the ſalt has been removed from the ſolution in which it cryſtallizes, it may be purified by diſſolving it in boiling water. The ſolution may be filtered, and allowed to cool, when the cryſtals are depoſited.

960 Properties. 2. The cryſtals of this ſalt are moſt commonly in the form of ſquare plates or of parallelopipeds, of a ſhining ſilvery white colour. The primitive form of the cryſtals is an obtuſe, rhomboidal priſm; they are very tranſparent and brittle; the taſte is cool, pungent, and diſagreeable, very different from that of nitrate of potaſh. When it is rubbed ſmartly, it phoſphoreſces, and gives out a great quantity of ſparks or luminous traces.

3. It becomes yellow after long expoſure to the air, but is otherwiſe not changed. It is ſoluble in about 20 parts of water at the ordinary temperature of the atmoſphere; but boiling water diſſolves about one-third of its weight, ſo that the whole is nearly cryſtallized by cooling.

961 Action of heat. 4. When this ſalt is expoſed to heat, although it contains a conſiderable proportion of water of cryſtallization, it fuſes quietly; and when the heat is increaſed, it gives out a quantity of oxygen gas nearly equal to one-third of its weight. This is the pureſt oxygen gas that can be obtained.

5. But the moſt extraordinary effects of this ſalt are thoſe produced by its action on combuſtible ſubſtances.

961 Of charcoal. *a*. If a ſmall quantity of charcoal reduced to powder and this ſalt be rubbed together in a mortar, there is a ſlight exploſion, and the charcoal is inflamed.

963 Of ſulphur. *b*. Three parts of the ſalt with one of ſulphur, rubbed together in a mortar, produce a violent detonation. Or, if the ſame mixture is ſtruck with a hammer on an anvil, there is an exploſion like the report of a piſtol (y).

964 Of phoſphorus. *c*. The ſame effect is produced by employing phoſphorus, and treating it in the ſame way with this ſalt. One or 1½ grains of the ſalt ſhould firſt be reduced to powder, and brought together to one place in the bottom of the mortar, and then introducing the phoſphorus, and rubbing it ſtrongly on the ſalt, a violent exploſion will inſtantly take place. A ſimilar detonation may be produced with the ſame ſubſtances, by percuſſion.

d. Three parts of the ſalt, one-half part of ſulphur, and one-half charcoal, give more rapid and ſtronger detonations, with the evolution of a very bright flame. Detonations are alſo produced, by treating this ſalt with ſugar, gums, oils, and ſome metallic ſubſtances.

965 Of acids. 6. When concentrated ſulphuric acid is poured upon this ſalt, there is a conſiderable detonation; it is thrown about to a great diſtance, ſometimes with a red flame; and there is exhaled a brown vapour, accompanied with a ſtrong odour of oxymuriatic acid. Even when a lighted taper is brought into contact with the gas which is diſengaged, it explodes more violently than when the acid firſt came in contact with the ſalt. In ſome caſes, the exploſion was ſo ſudden and ſo violent, that it broke the veſſels in which the mixture was made. This happened to Mr Hoyle of Mancheſter, and afterwards to Mr Chenevix; ſo that experiments with ſulphuric acid and this ſalt, ſhould be conducted with ſmall quantities, and with great caution. If concentrated ſulphuric acid be poured on any of the mixtures of this ſalt with ſulphur, charcoal, the metals, or with ſugar, there is an inſtantaneous inflammation, the moſt brilliant that can be conceived. There is no detonation, but the combuſtion is extremely rapid, and the odour of oxymuriatic acid is perceptible. Concentrated nitric acid poured upon this ſalt, cauſes it to crackle and efferveſce, but without exploſion, and without flame; oxymuriatic acid gas is diſengaged. With the muriatic acid this ſalt produces efferveſcence, with the evolution of a conſiderable quantity of gas, ſimilar in colour and ſmell to oxymuriatic acid gas; but in ſome of its properties conſiderably different. This gas is more rapidly abſorbed by water. If a ſmall jar or bottle be filled with this gas, and a ſlip of paper moiſtened with ether be introduced into it, and the mouth of the jar be ſlightly covered to prevent the contact of air, an exploſion takes place, with a depoſition of charcoal. A ſimilar experiment may be made, by moiſtening a feather with oil of turpentine, and introducing it into the jar filled with this gas. It inſtantly takes fire with a red flame, and a great quantity of black ſmoke.

966 Compoſition. 7. According to the analyſis of this ſalt, as given by Fourcroy, it conſiſts of

Muriate of potaſh,	67
Oxygen,	33
	100 *.

* Fourcroy Connaiſs. Chim. iii. p. 226.

But according to the experiments of Mr Chenevix, its conſtituent parts are,

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(x) "The acid elaſtic fluid (ſays Dr Higgins), which iſſues when two pounds of manganeſe are mixed and diſtilled with two or three of ordinary ſpirit of ſea ſalt (muriatic acid), may all, except a ſmall portion of phlogiſtic air, be condenſed in a ſolution of fixed vegetable alkali; and the ſolution, thus impregnated, yields a conſiderable quantity of nitre, which cryſtallizes in the ordinary form, and detonates on red-hot coals. The ſolution at the ſame time yields regenerated ſea-ſalt (muriate of potaſh)." *Higgins*, *Exper*. p. 181.

(y) In experiments with this ſalt, the quantity employed ſhould never exceed one or two grains, at leaſt by thoſe who have not been previouſly acquainted with its terrible effects.

Acid,	58.3
Potaſh,	39.2
Water,	2.5
	100.0 †

967 Uſes. 8. This ſalt has been employed in bleaching; but other ſubſtances, particularly lime, have been ſubſtituted for the potaſh; ſo that at preſent it is more rarely uſed. It was propoſed by M. Berthollet, when he firſt obſerved its effects, to employ it as a ſubſtitute for nitre in the manufacture of gunpowder; and when it was tried in the way of experiment, it ſeemed to be more powerful than the uſual component parts of powder; but when it was attempted to be made in the large way, at Eſſone in the year 1788, a dreadful accident, which happened by the ſpontaneous exploſion of the mixture, in the death of M. le Tors, and Mademoiſelle Chevraud, prevented its effects from being fairly proved. The danger which attends the trituration of the proper materials with this ſalt, has precluded any future attempt.

7. Fluate of Potaſh.

968 Little known. This ſalt has only been examined by Scheele and Bergman. It is the combination of fluoric acid with potaſh. When the acid is ſaturated, there is formed a gelatinous maſs, which does not cryſtallize, and which has a ſlightly acrid ſaline taſte. When it is evaporated to dryneſs, and expoſed to the air, it attracts moiſture. If it be ſtrongly heated in a crucible, it fuſes without efferveſcence. It then becomes cauſtic, is very ſoluble in water, and is decompoſed by the ſulphuric and nitric acids.

8. Borate of Potaſh.

This is a compound of the boracic acid and potaſh; but very little is known of its nature and properties. It is prepared by decompoſing nitre by means of the boracic acid with the aſſiſtance of heat. The heat drives off the nitric acid, and there remains behind a white, half-fuſed porous maſs, which is ſoluble in water, and yields by evaporation and cooling, ſmall cryſtals. The ſame ſalt may be formed by direct combination of the boracic acid and potaſh. This ſalt ſeems to be analogous in many of its properties to borax.

9. Phoſphate of Potaſh.

This combination of phoſphoric acid with potaſh was announced and deſcribed by Lavoiſier in the year 1774. Its properties have been more carefully inveſtigated by Vauquelin; but from the inveſtigation of other chemiſts it appears, that there are two ſalts formed from the ſame acid and baſe; the one in which they are neutralized, and the other in which there is an exceſs of acid.

a. Superphoſphate of Potaſh, is formed by the direct combination of phoſphoric acid and potaſh. This ſalt does not cryſtallize, but exiſts in a gelatinous form, and has a ſweetiſh ſaline taſte. Its ſpecific gravity, when dry, is 2.8516. It is very ſoluble in water; it attracts the moiſture from the air, and becomes thick and viſcid. 969 Properties.

970 Action of heat. 2. When heated, it undergoes the watery fuſion, then froths up, and becomes dry. When the temperature is raiſed, it melts into a tranſparent glaſs. The ſulphuric, nitric, and muriatic acids decompoſe this ſalt. It has been applied to no uſe.

b. Phoſphate of Potaſh.—This ſalt may be formed by expoſing pure potaſh and the former variety to a ſtrong heat. The alkali combines with the exceſs of acid, and neutralizes the whole. By the action of heat, a white-coloured ſubſtance is obtained, which is the phoſphate of potaſh. 971 Action of heat. It is ſcarcely ſoluble in cold water, but ſoluble in hot water; and as the ſolution cools, there is depoſited a ſhining gritty powder. This ſalt is very fuſible. Before the blow-pipe it melts into a tranſparent bead, which becomes opaque on cooling.

972 Of acids. 2. This ſalt is ſoluble in nitric, muriatic, and phoſphoric acids, and forms with them thick glutinous ſolutions. It has not yet been applied to any uſe.

10. Phoſphite of Potaſh.

This ſalt is prepared by diſſolving carbonate of potaſh in phoſphorous acid. The ſolution is evaporated, and it depoſits cryſtals of the *phoſphite of potaſh*. It has a ſharp ſaline taſte. It is cryſtallized in four-ſided rectangular priſms with dihedral ſummits. It is very ſoluble in water, requiring only three parts of it for ſolution. It is not altered by expoſure to the air.

11. Carbonate of Potaſh.

1. This ſalt, which is a compound of carbonic acid and potaſh, has been known under a great variety of names, in ſome meaſure deſcriptive of its properties, before its compoſition was diſcovered by Dr Black.

973 Preparation. 2. This ſalt is obtained from vegetable matters by burning, and waſhing out the ſalt and evaporating it; but the potaſh obtained in this way is not fully ſaturated with carbonic acid. After it has been purified from foreign ingredients, the ſaturated carbonate of potaſh may be prepared by expoſing a pure ſolution of potaſh to carbonic acid gas, as it is diſengaged from fermenting liquors. The carbonate of potaſh, as it is formed, cryſtallizes in the ſolution. The cryſtals may be taken out and dried upon unſized paper, and put up in well-cloſed bottles. Or it may be prepared by paſſing a current of carbonic acid gas, diſengaged from the carbonate of lime by an acid, into a ſolution of potaſh, in tall narrow bottles. The carbonate cryſtallizes at the ſurface of the liquid. It may alſo be obtained by the proceſs of Berthollet, which is to diſtil with an unſaturated ſolution of potaſh, ſolid carbonate of ammonia, from which the potaſh carries off the carbonic acid, while the ammonia is diſengaged in the ſtate of gas.

974 Properties. 3. The carbonate of potaſh cryſtallizes in quadrangular priſms, terminated by quadrangular pyramids. It has a ſweet alkaline taſte, and changes vegetable blues to a green colour. The carbonate of potaſh requires very near four times its weight of water to diſſolve it. At the boiling temperature it diſſolves five-ſixths of its weight. It does not cryſtallize by cooling, but only by ſlow evaporation. Pelletier has obſerved, that carbonate of potaſh diſſolved in boiling water, gives out bubbles of carbonic acid gas, which ſhews that this ſalt loſes a portion of its acid at this temperature. Its ſpecific gravity is 2.012. When it is expoſed to the air, it ſoon effloreſces. When it is

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† *Phil. Tranſ.* 1802.

deliqueſcent, it is owing to part of the potaſh being unſaturated with carbonic acid.

975 Action of heat. 4. When it is expoſed to a ſlight degree of heat, it loſes its water of cryſtallization. Part of its carbonic acid alſo ſeparates from it, but the whole cannot be driven off by this proceſs. The laſt portions adhere with a very ſtrong affinity.

976 Decompoſed by ſulphur. 5. When the carbonate of potaſh is heated with ſulphur at a high temperature, the acid eſcapes in the ſtate of gas; and there is formed a ſulphuret, at the moment of the effervеſcence produced by the extrication of the acid.

977 By all acids. 6. All the acids hitherto diſcovered, have the property of ſeparating the carbonic acid from potaſh, and of forming with its baſe particular ſalts. This ſalt loſes more than a third of its weight, by being deprived of its carbonic acid. The component parts of carbonate of potaſh are, according to,

	Bergman,	Pelletier,	Kirwan.
Carbonic acid,	20	43	43
Potaſh,	48	40	41
Water,	32	17	16
	100	100	100

978 Potaſh of commerce. 7. Potaſh of commerce is never ſaturated with carbonic acid. It is in this ſtate that the carbonate of potaſh is generally employed. It has a ſtronger alkaline taſte, and is more acrid and corroſive. It ſoon deliqueſces when expoſed to the air. It does not combine with a greater proportion of carbonic acid, merely by expoſure to the atmoſphere. For the purpoſes of the manufacturer it is of great importance to be able to aſcertain, by a ſimple teſt, the quantity of pure potaſh in the different kinds which are brought to market. 979 Teſts of its purity. Mr Kirwan has propoſed to diſcover the proportion of the ſalt, by determining the quantity of the earth of alum which is precipitated by the potaſh. A different method has been propoſed by Vauquelin with the ſame view. His method is to ſaturate a given weight of the ſalt with nitric acid of known denſity. He has alſo made a number of experiments to diſcover the quantity of foreign ingredients in different kinds of potaſh. The following table ſhews the kinds of matter and the proportions in ſix ſpecies of potaſh *.

	Potaſh.	Sulphate of Potaſh.	Muriate of Potaſh.	Inſoluble Reſidue.	Carbonic Acid and Water.	Total.
Potaſh of Ruſſia,	772	65	5	56	254	1152
Potaſh of America,	857	154	20	2	119	1152
American pearl-aſh,	754	80	4	6	308	1152
Potaſh of Treves,	720	165	44	24	199	1152
Potaſh of Dantzic,	603	152	14	79	304	1152
Potaſh of Voſges.	444	148	510	34	304	1440

12. Arſeniate of Potaſh.

980 Preparation. 1. The compound of arſenic acid and potaſh forms a ſalt which does not cryſtallize. When evaporated to dryneſs, this ſalt deliqueſces in the air, gives a green colour to ſyrup of violets without changing the tincture of turnſole.

981 Properties. 2. When ſtrongly heated it fuſes into a white glaſs; and by the contact of ſilica and alumina in the crucible it paſſes to the acidulous ſtate, having been deprived of part of the potaſh. Expoſed to a red heat, in cloſe veſſels with charcoal, the arſenic is ſublimed. It is decompoſed by the ſulphuric acid. It decompoſes ſalts which have baſes of lime and magneſia; forming in the ſolution arſeniates of lime and magneſia *.

982 With more acid cryſtallizes. *Superarſeniate of potaſh.*—If the arſenic acid be added to the arſeniate of potaſh till it no longer change the colour of violets, but reddens that of turnſole, it yields regular tranſparent cryſtals in quadrangular priſms, terminated by tetrahedral pyramids. This ſalt is the *arſenical neutral ſalt* of Macquer. He obtained it by decompoſing the nitrate of potaſh, by means of the white oxide of arſenic, employing equal parts of each. It is different from the former, becauſe it cryſtallizes, reddens vegetable blues, and does not decompoſe ſalts with a baſe of lime or magneſia.

13. Tungſtate of Potaſh.

983 Preparation. 1. This compound of tungſtic acid and potaſh, is formed by diſſolving the oxide of the metal in a ſolution of pure potaſh, or its carbonate. The alkali is not fully neutralized. The ſalt precipitates from the ſolution by evaporation, in the ſtate of a white powder.

984 Properties. 2. It is diſtinguiſhed by a cauſtic metallic taſte, deliqueſces in the air, and is ſoluble in water. This ſolution in water is decompoſed by all the acids which produce a white precipitate. This precipitate is a triple ſalt, differing according to the nature of the acid which is employed †.

14. Molybdate of Potaſh.

985 Preparation. 1. The compound of molybdic acid and potaſh is formed by detonating three parts of nitre and one of

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* *Ann de Chim.* xl. 284.

* *Fourcroy Connaiſs.* v. 85.

† *Jour de Mines*, N° 19. p. 21.

ſulphuret of molybdena in a crucible; or by combining directly the molybdic acid with potaſh. This ſalt affords ſmall irregular cryſtals, from its ſaturated ſolution in boiling water. According to Klaproth, the cryſtals are in the form of ſmall rhomboidal plates, of a ſhining appearance, and heaped together.

986 Properties. 2. The taſte is metallic. When expoſed to the blow-pipe on charcoal, they fuſe rapidly, without ſwelling up, and are converted into ſmall globules, which are abſorbed by the charcoal. In a ſilver ſpoon they are melted by the blow-pipe into ſmall gray particles, which ſhrink on cooling, and depoſit, during the proceſs, a whitiſh powder. This ſalt is completely ſoluble in diſtilled water with the aſſiſtance of heat. It has an exceſs of acid, and is therefore an acidulous molybdate of potaſh, or ſupermolybdate of potaſh. It is decompoſed by the nitric acid, which unites with the alkali, and precipitates the molybdic acid in the form of ſmall cryſtals *.

15. Chromate of Potaſh.

Nothing farther is known of the nature of this ſalt, than that it is eaſily formed by the combination of the chromic acid with potaſh, and that the cryſtals are of an orange colour, which ſufficiently diſtinguiſhes them from the cryſtals of all other ſalts.

16. Columbate of Potaſh.

Columbic acid digeſted for an hour with a ſolution of potaſh, affords this ſalt by evaporation and cooling, in the form of white glittering ſcales, reſembling the concrete boracic acid. It is not changed by expoſure to the air, has a diſagreeable acrid taſte, and is not very ſoluble in cold water; but after it is diſſolved, the ſolution is perfect and permanent. It is decompoſed by nitric acid, and precipitates in the form of white powder †.

17. Acetate of Potaſh.

987 Names. 1. This ſalt, which is a compound of acetic acid and potaſh, has been long known under a variety of names, which were derived from the ſubſtances from which it was obtained; or, from its properties and effects. It was called *regenerated tartar*, *ſecret foliated earth of tartar*, *eſſential ſalt of wine*, *digeſtive ſalt of Sylvius*, *diuretic ſalt*.

988 Preparation. It may be formed by ſaturating carbonate of potaſh with diſtilled vinegar, and by evaporating the ſolution ſlowly to dryneſs. When the heat is too great, the acid is decompoſed, and the ſalt aſſumes a brown colour.

989 Properties. 2. This ſalt has a pungent, and ſomewhat alkaline taſte. Expoſed to the air, it becomes moiſt. It is very ſoluble in water, and if the ſolution be diluted, it is ſpontaneouſly decompoſed in cloſe veſſels. Thick, mucous flakes are depoſited.

990 Act. on of heat. 3. When it is heated, it melts and froths up, and is then decompoſed and charred. When diſtilled in a retort, it yields an acid liquid, an empyreumatic oil, and a great deal of carbonic acid gas, and carbonated hydrogen gas. In this proceſs the acid is completely decompoſed; what remains in the retort is potaſh mixed with charcoal. According to Prouſt, this acid liquid contains ammonia and the pruſſic acid, and the carbonate and pruſſiate of potaſh are found in the retort ‡.

4. This ſalt is decompoſed by the ſtrong acids. Diſtilled with ſulphuric acid, it yields an acetic acid which is very acrid.

991 Compoſition. The component parts of the acetate of potaſh are, according to Dr Higgins,

38.5 Acid and water,
61.5 Potaſh.

100.0

18. Oxalate of Potaſh.

The compound of oxalic acid and potaſh may be formed by direct combination of the acid and the alkali. The oxalic acid combines in two proportions with potaſh, either in a ſmall quantity, or in ſufficient quantity to ſaturate the potaſh. When the acid is in exceſs, it is called the *acidulous oxalate*, or *ſuperoxalate of potaſh*.

992 Preparation. 1. The oxalate of potaſh is formed by completely ſaturating the oxalic acid with potaſh; and by adding an exceſs of the alkali, cryſtals are obtained.

2. Without this exceſs of acid, the ſalt does not cryſtallize, but aſſumes a gelatinous form.

993 Properties. 3. When this ſalt cryſtallizes, it is in the form of ſix-ſided priſms, with two-ſided ſummits. It is decompoſed by heat, and alſo by the ſtrong acids, which deprive it of a portion of the potaſh, and convert it into the acidulous oxalate. With an addition of oxalic acid the acidulous oxalate is alſo formed.

994 Exiſts in plants. *Superoxalate of Potaſh.*—1. This ſalt exiſts ready formed in the *rumex acetoſa*, and the *oxalis acetoſella*; hence it has been diſtinguiſhed by the name of *ſalt of ſorrel*, becauſe it is extracted from this plant.

995 Preparation. 2. This ſalt may be formed by gradually combining potaſh with a ſaturated ſolution of oxalic acid. When a ſufficient quantity of the alkali has been added, the ſalt is precipitated in cryſtals. Scheele diſcovered that the ſalt which is extracted from theſe plants, is in this ſtate of combination. He proved the exiſtence of the acid, and he ſhewed that the natural ſalt might be imitated by this proceſs.

996 Properties. 3. The cryſtals of this ſalt are in the form of ſmall opaque parallelopipeds. The taſte is acid, pungent and bitter. It is not very ſoluble in cold water, but ſoluble in about ten times its weight of boiling water. Expoſed to the air, it undergoes no change. It is decompoſed by heat.

19. Tartrate of Potaſh.

997 Preparation. 1. This is a compound of tartaric acid and potaſh. It has been long known under the name of *ſoluble tartar*, and *vegetable ſalt*. It is formed by adding tartar or cream of tartar to a hot ſolution of carbonate of potaſh. The additions of the tartar are to be continued as long as there is any effervеſcence. The ſolution is then boiled for half an hour, filtered and evaporated, till a pellicle appears on the ſurface, and when it is allowed to cool ſlowly, it depoſits cryſtals.

998 Properties. 2. The cryſtals of this ſalt are in the form of long, rectangular priſms, terminated by two-ſided ſummits. This ſalt has a bitter taſte. The ſpecific gravity is 1.5567. Expoſed to the air it is deliqueſcent. Four parts of cold water diſſolve one of the ſalt; hot water diſſolves a greater quantity. When heated, it ſwells up and blackens. By diſtillation it yields an acid liquid, ſome oil, and a great quantity of gas. It leaves

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* Ann. de Chim. viii. p. 106.

† Phil. Tranſ. 1802. p. 58.

‡ Annal. de Chim. xlii. p. 132.

behind a conſiderable portion of alkali, mixed with charcoal. It is decompoſed by the ſtronger acids, which deprive it of a portion of its potaſh, and reduce it to the acidulous tartrate, which is precipitated in the ſolution. By the addition of tartaric acid to the ſolution of this ſalt, it is alſo converted into the acidulous tartrate.

Supertartrate of Potaſh.—1. This is a compound of tartaric acid with potaſh, but with an exceſs of acid. 999 Tartar. The ſubſtance which is well known under the name of *tartar*, and which is found encruſted on the bottom and ſides of veſſels in which wine has been kept, is the ſupertartrate or the acidulous tartrate of potaſh; but in this ſtate it is very impure. 1000 Purification. It is purified by ſolution in boiling water, and by filtration while it is hot. When it cools, there is a copious depoſition of the pure ſalt in cryſtals. Theſe are the cryſtals or cream of tartar.

1001 Contains an alkali. 2. It had been long known to chemiſts, that potaſh could be obtained from tartar, by expoſing it to a ſtrong heat, which produced a controverſy whether the alkali exiſted ready formed in the tartar, or whether it was not, in ſome way or other, produced by the action of heat during the proceſs. This point was not fully ſettled till Scheele diſcovered the method of extracting the acid, the other component part of tartar.

1002 Properties. 3. The cryſtals of tartar are in the form of ſmall irregular cryſtals, but chiefly of ſix-ſided priſms. This ſalt has an unpleaſant acid taſte, is very brittle, and its ſpecific gravity is 1.953. It requires for its ſolution 30 parts of boiling water, and 60 of cold water. It undergoes no change when expoſed to the air, but in the ſolution in water the ſalt is decompoſed, depoſiting a mucous matter, and leaving behind an impure carbonate of the alkali.

1003 Action of heat. 4. Expoſed to heat, it melts, ſwells up, blackens, and the acid is totally decompoſed. When it is diſtilled, an oily matter, and an acid liquid, which is an impure acetic acid, with a great quantity of carbonic acid, are obtained. This acid was formerly called *pyrotartarous acid* (z).

1004 Compoſition. 5. The component parts of tartar, according to Bergman are,

Acid	77
Potaſh	23
	100

Or of the ſaturated ſalt,

Tartrate of potaſh	56
Acid	44
	100

By the analyſis of Thenard, it is compoſed of

Acid	57
Potaſh	33
Water	7
	97 [*]

20. Citrate of Potaſh.

1005 Properties and compoſition. This compound of citric acid with potaſh may be formed by combining together 36 parts of the acid with 61 parts of the carbonate of the alkali. This ſalt is very ſoluble in water, but little diſpoſed to cryſtallize. It is very deliqueſcent. According to the analyſis of Vauquelin, it conſiſts of

Acid	55.55
Potaſh	44.45
	100.00

21. Malate of Potaſh.

This ſalt, which is a compound of malic acid and potaſh, is deliqueſcent, and very ſoluble in water, but its properties are little known.

22. Gallate of Potaſh.

The compound of gallic acid and potaſh has little ſolubility in water, but its other properties are unknown.

23. Benzoate of Potaſh.

This ſalt, compoſed of benzoic acid and potaſh, cryſtallizes on cooling, into ſmall needles. A drop of the ſolution ſpread on the ſide of the veſſel, as it evaporates, exhibits an arborcſcent cryſtallization. It has a ſharp ſaline taſte, is deliqueſcent in the air, and very ſoluble in water.

24. Succinate of Potaſh.

This compound of ſuccinic acid and potaſh, forms cryſtals in three-ſided priſms; the taſte is bitter and ſaline; it deliqueſces in the air, and is very ſoluble in water.

25. Saccolate of Potaſh.

This is the compound of ſaclactic acid and potaſh. It forms ſmall cryſtals, which are ſoluble in eight times their weight of boiling water.

26. Camphorate of Potaſh.

1006 Preparation. 1. This ſalt, which is a combination of camphoric acid and potaſh, may be formed by ſaturating a ſolution of carbonate of potaſh with camphoric acid. When the effervеſcence has ceaſed, the ſolution is to be evaporated with a gentle heat, when it affords cryſtals by cooling.

1007 Properties. 2. The camphorate of potaſh is in the form of regular hexagonal cryſtals, which are white and tranſparent; the taſte is bitteriſh and ſlightly aromatic. Expoſed to the air, when it is moiſt, the ſalt loſes its tranſparency; but if the air is dry, there is no change. It is ſoluble in four parts of boiling water; but in water at the temperature of 60°, it requires 100 parts.

1008 Action of heat. 3. Expoſed to heat before the blow-pipe, it burns with a blue flame, and the potaſh remains behind pure. When the heat is ſtronger, it froths up, the acid is ſublimed, and it gives out a thick ſmoke, which is ſlightly aromatic.

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[*] *Ann de Chim.* xxxviii. p. 39.

(z) The pyrotartarous acid, the pyromucous, and the pyroligneous acids, were diſcovered by Fourcroy and Vauquelin to be nothing elſe than the acetic acid impregnated with extraneous ſubſtances, particularly with what is called an empyreumatic oil. See *Annales de Chimie*, xxxv. p. 161.

1009 Of acids. 4. It is decompoſed by the mineral acids. If the ſolution be much diluted with water, the decompoſition is not perceptible; but if brought to the conſiſtence of a thick ſyrup, the camphoric acid cryſtallizes in cooling. A new ſalt alſo is partially cryſtallized. By ſolution in cold water the acid may be ſeparated.

1010 Of alcohol. 5. The camphorate of potaſh is ſoluble in alcohol, and it burns with a deep blue flame.

1011 Decompoſition. 6. It is decompoſed by, 1. Nitrate of barytes and of ſilver; 2. By all the ſalts whoſe baſe is lime; 3. Sulphate of iron; 4. Muriate of tin and of lead *.

27. Suberate of Potaſh.

1012 Preparation. 1. This ſalt, which is a compound of ſuberic acid with potaſh, is formed by ſaturating the acid with the cryſtallized carbonate of the alkali.

1013 Properties. 2. It cryſtallizes in four-ſided priſms, which have unequal ſides. The taſte is bitter and ſaline. It reddens vegetable blues, and is very ſoluble in water.

1014 Action of heat. 3. Expoſed to heat, it ſwells up and melts; the acid is diſſipated, and the potaſh remains behind. It is decompoſed by the mineral acids, which combining with the potaſh, precipitate the ſuberic acid. It is decompoſed alſo by barytes, by all the metallic ſalts, by ſulphate and phoſphate of alumina, by the nitrates and muriates of lime and of alumina †.

28. Mellate of Potaſh.

The mellitic acid combines with potaſh, and forms this ſalt, which is fully ſaturated with the acid, and in this ſtate it cryſtallizes in long priſms; but with an additional portion of acid, an acidulous mellate, or ſupermellate, is formed. This ſalt, as Vauquelin obſerves, alſo cryſtallizes; but the properties of theſe ſalts have not been much examined ‡.

29. Lactate of Potaſh.

This ſalt is only known as being deliqueſcent, and ſoluble in alcohol.

30. Pruſſiate of Potaſh.

The compound of pruſſic acid and potaſh, is formed by diſſolving the alkali in the acid. The ſalt is very ſoluble in water, produces a green colour on vegetable blues, and, with the application of a moderate heat, it is decompoſed.

31. Sebate of Potaſh.

This ſalt has been little examined. According to the experiments of Thenard, it has little taſte, is not affected by expoſure to the air, and is decompoſed by the ſulphuric, nitric, and muriatic acids: the ſolution, if it be concentrated, becoming ſolid on the addition of the acid from the cryſtallization of the ſebacic acid ||.

32. Urate of Potaſh.

This compound of the uric acid with potaſh, is formed by triturating the acid with the alkali. The mixture aſſumes the form of a ſaponaceous paſte, which is very ſoluble in water, when there is an exceſs of the alkali, but leſs ſo when the acid is ſaturated. This ſalt has little taſte; when neutralized is not very ſoluble in water, and ſeems little diſpoſed to cryſtallize. It is decompoſed by the muriatic acid *.

IV. Compounds of Potaſh with Inflammable Subſtances.

1015 Alcohol. 1. Potaſh is very ſoluble in alcohol. The ſolution aſſumes a red colour, and becomes acrid. It is by a ſolution of potaſh in alcohol, that the former is obtained in a ſtate of purity; for the alcohol diſſolves the potaſh, while other ſubſtances are depoſited. By the application of heat to this ſolution, there is a partial decompoſition of the alcohol.

2. Ether has no perceptible action on potaſh.

1016 Fixed oils. 3. Potaſh readily enters into combination with the fixed oils, but particularly with that claſs of them denominated *fat oils;* and forms with them very important compounds, namely, ſoaps. The compound with potaſh and the fat oils is a *ſoft* ſoap.

1017 Volatile. 4. Potaſh alſo enters into combination with the volatile oils, but in very ſmall proportion, which likewiſe forms a ſpecies of ſoap.

SECT. II. *Of SODA and its Combinations.*

1018 Names. 1. Soda, the other fixed alkali, has been diſtinguiſhed by a great number of different names. It was called *foſſil* or *mineral alkali*, becauſe it was ſuppoſed that it only exiſted in the mineral kingdom. It is the ſubſtance which is mentioned in Scripture as a detergent, under the name of *nitre*.

1019 Found in the ſoil. 2. This alkali exiſts in great abundance in different parts of the earth, and particularly on the ſurface of the ſoil in Egypt, where it is diſtinguiſhed by the name of *natron*. It is alſo found on the walls of caves and places under ground, and old edifices.

1020 Obtained from plants. But the ſoda of commerce is generally obtained from different ſpecies of plants which grow on the ſea-ſhore; and as it is prepared from them, it has received different names in different countries. The *ſalſola ſoda* yields this alkali in greateſt abundance. This plant is called *barilla* in the Spaniſh language, and from this the ſoda which is prepared on the ſhores of that country, has been called *barilla aſhes*. For the purpoſes of commerce alſo, ſoda is prepared in great quantities from the aſhes of another tribe of marine plants, namely the *algæ*, and particularly from the *fuci*, all of which yield it in greater or leſs proportion. As it is prepared from theſe plants, it is known in France by the name of *varec*, and in Britain by the name of *kelp*. Soda exiſts in great abundance in the waters of the ocean. There it is in combination with the muriatic acid, forming the well-known compound of *common ſalt*.

1021 Firſt diſtinguiſhed from potaſh. 3. In many of their properties ſoda and potaſh approach very near to each other. They were accordingly conſidered as the ſame alkali, till, towards the middle of the 18th century, by the experiments of Duhamel, Pott, and Margraff, they were diſtinctly characteriſed, and the properties of each fully aſcertained.

1022 Purification. 4. The ſoda of commerce is in very different degrees of purity, according to the care and attention with which it is prepared, and the purpoſes for which it is intended. To have it perfectly pure, it muſt be ſubjected

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* *Annal. de Chim.* xxvii. p. 24.

† *Annal. de Chim.* xxiii. p. 52.

‡ *Ibid.* xxxvi. p. 208.

|| *Ibid.* xxxix. p. 193.

* *Fourcroy Connaiſ. Chim.* x. p. 221.

jected to a ſimilar proceſs with thoſe which have been already detailed for the purification of potaſh; and by means of theſe proceſſes it may be procured in a ſolid and cryſtalline form.

1023 Properties. 5. When ſoda is in a ſtate of purity, it is uſually in the form of ſolid plates, of a grayiſh white colour, and the taſte exactly ſimilar to that of potaſh. It is alſo extremely cauſtic and corroſive. By ſlow evaporation from a ſolution in alcohol, it aſſumes the form of priſmatic cryſtals; but theſe, when expoſed to the air, very ſoon eﬄoreſce, and fall to powder. Soda changes the blue colour of vegetables to green. Its ſpecific gravity is 1.336. 1024 Action of heat. When it is expoſed to heat, it ſoftens, and readily melts. It liquefies by the action of heat like an oily matter, and when it becomes red-hot, boils, and is reduced to vapour, which is the ſoda unchanged, extremely acrid, and corroding the ſkin when it comes in contact with it.

1025 Of air and water. 6. When expoſed to the air, it firſt becomes moiſt and ſoft, by abſorbing water and carbonic acid; but when the air becomes dry, it eﬄoreſces and falls into a powder; and in this reſpect is ſufficiently diſtinguiſhed from potaſh. Soda has a very great affinity for water. When the dry alkali is moiſtened with water, it is abſorbed, and becomes ſolid, with the extrication of caloric. When more water is added, it diſſolves, and alſo gives out heat, and a peculiar odour, which is no doubt owing to a portion of the alkali raiſed in the ſtate of vapour along with the water.

1026 A ſimple ſubſtance. 7. Soda, as well as potaſh, is to be conſidered as a ſimple ſubſtance; for no attempt which has yet been made to decompoſe it has ſucceeded. Supported by certain analogies, Fourcroy is of opinion that ſoda is a compound of magneſia and azote; and he thinks this conjecture derives ſome degree of probability from the conſtancy with which magneſia accompanies ſoda in the waters, and different compounds, of which this alkali makes a part; eſpecially in animal matters and marine productions. 1027 Conjectures about its compoſition. Vauquelin, he obſerves, has detected magneſia in conſiderable abundance in the aſhes of the *ſalſoſa ſoda*; and the ſame earth is always obtained in great quantity during the proceſs for the extraction and purification of ſoda.

8. The affinities of ſoda are the ſame with thoſe of potaſh.

9. Soda is employed for many ſimilar purpoſes as potaſh. On account of ſome of its qualities, it is preferred to potaſh in many manufactures, becauſe it is leſs acrid and corroſive, and is therefore leſs apt to deſtroy the texture of animal and vegetable matters to which it is applied.

I. Action of Phoſphorus on Soda.

1028 Phoſphorus. Soda ſcarcely enters into combination with phoſphorus. There is no phoſphuret formed either by the dry or humid way; but when phoſphorus is boiled with a pure ſolution of ſoda, phoſphorated hydrogen gas is evolved in the ſame way as when it is treated with potaſh.

II. Action of Sulphur on Soda.

1029 Sulphur. Soda readily combines with ſulphur by ſimple trituration, by fuſion, and by the humid way. In the two firſt caſes, there is formed a ſulphuret of ſoda, which may be decompoſed by heat, and by the acids, and which decompoſes water in the ſame way as the ſulphuret of potaſh. By the humid way there is formed a hydrogenated ſulphuret of ſoda, which has an extremely fetid odour, and emits, by the action of the acids which decompoſe it, ſulphurated hydrogen gas.

Hydroſulphuret of Soda.

This may be prepared in the ſame way as the hydroſulphuret of potaſh. It forms a cryſtallized ſalt in the ſhape of four-ſided priſms, terminated by quadrangular pyramids. The cryſtals are colourleſs, inodorous, and very ſoluble in water. When this ſalt is expoſed to the air, it deliqueſces, and becomes of a green colour. It is decompoſed by the action of acids. Soda, it would appear, has leſs affinity for ſulphur and ſulphurated hydrogen, than potaſh.

III. Compounds of Soda with the Acids.

1. Sulphate of Soda.

1. This ſalt, which is a compound of ſulphuric acid and ſoda, is well known under the name of *Glauber's ſalt*, from the name of Glauber, a German chemiſt, who diſcovered it, in examining the reſiduum of the decompoſition of common ſalt by means of ſulphuric acid. It has alſo been called the *admirable ſalt of Glauber*, *vitriolated mineral alkali*, and *vitriol of ſoda*. 1030 Names.

1031 Preparation. 2. This ſalt may be obtained by the direct combination of ſulphuric acid and ſoda. But it is more commonly prepared by the decompoſition of muriate of ſoda or ſea ſalt, by means of ſulphuric acid. The ſolution is then to be filtered, purified and cryſtallized in the uſual way.

1032 Properties. 3. It cryſtallizes by ſlow evaporation, in tranſparent, ſix-ſided priſms, terminated by two-ſided ſummits; but the cryſtals are ſeldom regular, and the ſides of the priſms are furrowed. The taſte is cool, bitter, and nauſeous. The ſpecific gravity is 1.4457 *.

1033 Action of air. 4. When it is expoſed to the air, eſpecially when the air is dry, it eﬄoreſces, which is owing to the eſcape of the water of cryſtallization. It loſes about 0.3 of its weight. It is very ſoluble in cold water, and it requires only $\frac{3}{5}$ths of its weight of boiling water.

1034 Of heat. 5. When it is expoſed to heat, it melts, on account of the great quantity of water of cryſtallization which it contains, and this is called the *aqueous fuſion*. Afterwards it dries, when the water is evaporated. It loſes about .58 of its weight. To melt it afterwards, it muſt be expoſed to a red heat long continued, which is called the *igneous fuſion*. After it is cooled, it is found to have ſuffered no change. When water is added, it returns to its former ſtate.

1035 Compoſition. 6. It is decompoſed by means of charcoal, which at a red heat converts it into ſulphuret of ſoda, by depriving the acid of its oxygen. The component parts of this ſalt, according to Bergman, are

Acid	27
Soda	15
Water	58
	100

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* *Ann. de Chim.* xxviii. p. 12.

But according to Mr Kirwan, it is compoſed of

	Cryſtallized.		Dried at 700°.
Acid	23.52	-	56
Soda	18.48	-	44
Water	58	-	0
	100.00		100*

It is decompoſed by barytes; and by potaſh, but leſs powerfully. Lime and ſtrontites are alſo capable of producing a partial decompoſition in the humid way, and in contact with the air.

7. This ſalt is a good deal employed in medicine, as a purgative; in chemiſtry, for the purpoſe of decompoſing other ſubſtances; and in the arts, for the extraction of ſoda.

2. Sulphite of Soda.

1036 Diſcovery. 1. This ſalt, which is a compound of ſulphurous acid and ſoda, was firſt taken notice of by Berthollet. It is prepared by paſſing ſulphurous acid gas into a ſaturated ſolution of carbonate of ſoda. The ſulphite of ſoda is precipitated at firſt, in a confuſed maſs of very ſmall cryſtals, which are re-diſſolved in warm water, and cryſtallize again on cooling.

1037 Properties. 2. The cryſtals of ſulphite of ſoda are in four-ſided priſms, two broad, and two narrow, terminated by two-ſided ſummits. They are perfectly tranſparent. The taſte is cool and ſulphureous. The ſpecific gravity is 2.9566.

1038 Action of the air. 3. Expoſed to the air, it effloreſces, and the powder formed on the ſurface is converted into a ſulphate. It is extremely ſoluble in water. Boiling water takes

1039 Of water. up more than its own weight. It cryſtallizes again on cooling, but ſometimes the ſolution is formed into a ſingle maſs when it is expoſed to the air; and if quickly cooled with agitation, it affords nothing but needle-formed cryſtals. This ſolution expoſed to the air is converted into the ſulphate.

1040 Of heat. 4. This ſalt readily undergoes the aqueous fuſion; if the heat be increaſed, a portion of ſulphur is driven off, and it is converted into a ſulphate.

5. It is decompoſed by means of the acids, which diſengage the ſulphurous acid in the ſtate of gas. The oxymuriatic acid gas brought into contact with a ſolution of this ſalt in water, inſtantly converts it into ſulphate. It is decompoſed by barytes, lime and potaſh; by the ſulphates of lime, of ammonia, and of magneſia.

1041 Compoſition. 6. The component parts of this ſalt have been found by analyſis to be,

Sulphurous acid	31
Soda	18
Water	51
	100

It has not been applied to any uſe.

3. Nitrate of Soda.

1042 Names. 1. This compound of nitric acid and ſoda was formerly known by the name of *cubic nitre*, and *rhomboidal nitre*. It is prepared by the direct combination of the acid with the alkali; or by decompoſing the muriate or carbonate of ſoda by nitric acid.

1043 Properties. 2. It cryſtallizes in the form of rhomboids and priſms. The taſte is cooling, but more bitter than that of the nitrate of potaſh.

3. The ſpecific gravity is 2.0964. Expoſed to the air, it attracts moiſture in a ſlight degree. It is ſoluble in three parts of cold water, and in leſs than its own weight of boiling water.

1044 Heat. 4. When it is thrown on red-hot coals, it decrepitates ſlightly; it is not ſo fuſible as nitre, but it is alſo decompoſed, and gives out oxygen gas mixed with azotic gas.

5. In its decompoſitions it is ſimilar to the nitrate of potaſh. It detonates, however, leſs powerfully with combuſtible bodies, and burns them with leſs facility. It is decompoſed by barytes and potaſh.

1045 Compoſition. 6. The proportions of its conſtituent parts are, according to Bergman,

Acid	43
Soda	32
Water	25
	100

According to Mr Kirwan,

	Dried in a heat of 400°.		After being ignited.
Acid	53.21	-	57.55
Soda	40.58	-	42.34
Water	6.21	-	00.00
	100.00		99.89 †.

4. Nitrite of Soda.

Chemiſts are not acquainted with the properties of this ſalt, although it is known to be formed after the partial decompoſition of nitrate of ſoda by means of heat.

5. Muriate of Soda.

1046 Common ſalt. 1. The muriate of ſoda, which is a compound of muriatic acid and ſoda, of all the other ſalts, from its great abundance in nature, and its valuable uſes, was the earlieſt known under the name of *ſalt*. It has been

1047 Names. diſtinguiſhed by the names of *common ſalt*, *kitchen ſalt*, *ſea-ſalt*, and ſometimes *ſal gem*, or *rock ſalt*.

1048 Abundant in nature. 2. This ſalt, which is found in ſuch abundance in nature, is never formed by art. In ſome parts of the world it exiſts in the bowels of the earth in large maſſes, from whence it is dug out, and ſimply reduced to powder, to be applied to uſe. But to obtain it from the waters of the ocean, in which it exiſts in different proportion, according to the temperature, the climate, and other circumſtances, it muſt be extracted by evaporation, which is effected by different proceſſes, according to the ſtrength of the ſolution, and the art of the manufacturer. In ſome parts of the world, all that is done is to collect the ſalt as it forms on the ſhores of the ſea, or on the rocks, by the evaporation of the water; but, in general, ſome art is neceſſary, even when the ſalt is obtained by ſpontaneous evaporation. On the coaſts of France, Spain, Portugal, and the ſhores of the Mediterranean, the ſea water is admitted into ponds during the flowing of the tide, and its return is prevented by ſluices, which are ſhut. It is then evaporated by the heat of the ſun; and, as this evaporation is gradual and ſlow, the ſalt cryſtallizes in large cubes, and it is known in commerce by the name of *bay*

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* Nichol. Jour. iii. p. 215.

* Nichol. Jour. iii. p. 215.

bay ſalt, from the circumſtance of its having been formed in creeks and bays of the ſea.

1049 By art.

3. But as this proceſs can only be followed in thoſe climates where there is a ſufficient degree of temperature to promote the evaporation ſpeedily; artificial heat is generally employed in the manufacture of ſalt. Sometimes the water is received in large ponds or flat veſſels, where it is allowed to evaporate for ſome time in the open air. It is afterwards boiled in flat iron pans; and, during the boiling, the impurities which riſe to the ſurface are removed. When the water is ſufficiently concentrated by the evaporation, a pellicle forms on the ſurface, which is the cryſtallization of the ſalt. This falls to the bottom, and another pellicle forms, till the whole of the ſalt is cryſtallized. The purity of the ſalt and the ſize of the cryſtals depend on the ſlow evaporation; and hence it is, that the pureſt ſalt, as it is manufactured it Britain, is that which is called *Sunday ſalt*. This is obtained from the laſt quantity of water which is boiled on the Saturday night; and, as it has time to cool ſlowly, the evaporation is more gradual, and the cryſtals are purer and larger.

1050 Purification.

4. But in this ſtate the muriate of ſoda is far from being pure. A very ingenious method has been propoſed for the purification of ſea ſalt by Lord Dundonald. The ſalts with which common ſalt is impregnated, are more ſoluble in water than the ſalt itſelf, and they diſſolve in much greater proportion in hot than in cold water. But common ſalt is nearly equally ſoluble in both. On this principle, therefore, the proceſs proceeds: A quantity of ſalt to be purified is put into a conical veſſel or baſket, which is ſlightly ſtopped at the apex, ſo that the water may paſs through. A ſaturated ſolution of common ſalt is then prepared. This ſolution of ſalt is poured boiling hot over the ſalt in the baſket. It can diſſolve none of the common ſalt in the baſket, becauſe it is already ſaturated; but, as it paſſes through, it diſſolves the other ſalts, and carries them along with it. It was found by experiment, that a ſaturated ſolution of 1lb. of common ſalt poured upon 10lbs. removes about $\frac{4}{5}$ths of all the foreign ſalts with which it is impregnated.

1051 By other proceſſes.

5. But, even after this proceſs, the ſalt is not perfectly pure for the purpoſes of chemiſtry. For this purpoſe it may be diſſolved in four parts of cold water. Filter the ſolution, to ſeparate any ſubſtances with which it is mixed. Pour into it ſome drops of a ſolution of ſoda, till no farther precipitate is obſerved. The fluid is then to be evaporated, and the ſalt, as it forms on the ſurface in ſmall cubical cryſtals, may be extracted; or it may be obtained in larger cryſtals by ſlow evaporation.

It may alſo be purified, by dropping into a ſolution of common ſalt, a ſolution of muriate of barytes, and then of carbonate of ſoda, as long as any precipitate is formed. The liquid may then be filtered and evaporated, till the ſolution cryſtallizes.

1052 Properties.

6. The muriate of ſoda cryſtallizes in perfect cubes; but from theſe there are ſeveral deviations in the form of its cryſtals. Sometimes the angles of the cubes are truncated; ſometimes they are in the form of octahedrons; which is the caſe when common ſalt is diſſolved in human urine, and allowed to evaporate ſpontaneouſly. But the primitive form of the cryſtal, as well as of the integrant particle, according to Hauy, is the cube. The taſte is ſweetiſh and agreeable, and is that which is properly called *ſalt*, with which all ſimilar taſtes are compared. The ſpecific gravity is 2.120.

1053 Action of air.

7. It undergoes no change by expoſure to the air. Common ſalt attracts moiſture from the atmoſphere; but this is owing to an impregnation of other ſalts which are deliqueſcent. Theſe ſalts are muriate of magneſia, ſulphate of magneſia, and ſulphate of lime. It is from theſe that it is to be purified by the proceſſes, which have been deſcribed above.

1054 and water

It is ſoluble in little more than 2½ times its weight of water, and it is almoſt equally ſoluble in hot and cold water.

8. When it is expoſed to a ſtrong heat, it decrepitates and gives out its water of cryſtallization. It melts in a red heat, and riſes in the air in the ſtate of white vapour; but it is unchanged; for if this vapour be collected by condenſing it in the cold, it is found to poſſeſs all the properties of common ſalt.

1055 Decompoſition.

9. The muriate of ſoda is decompoſed readily by ſulphuric acid, as well as by ſeveral other acids which have a ſtronger attraction for its baſe than the muriatic acid; or by the aid of double affinity, when an acid is in combination with a baſe, which at the ſame time acts on the muriatic acid.

1056 y ſulphuric acid.

It is by means of the ſulphuric acid that the chemiſt procures muriatic acid from the muriate of ſoda. Sometimes the ſalt is decompoſed by the ſame acid to obtain the ſoda. The ſulphuric acid combines with the ſoda, and forms ſulphate of ſoda, while the muriatic acid is diſengaged, and that it may not be loſt, it is conveyed into a leaden chamber, which contains a ſolution of ammoniac, where it forms ſal ammoniac. The ſulphate of ſoda is expoſed to ſtrong heat in a furnace, to drain off any portion of ſulphuric acid that it may contain. It is then mixed with its own weight of chalk, and half its weight of charcoal in powder. The mixture is ſtrongly heated in a reverberatory furnace, and occaſionally ſtirred to permit the eſcape of gas and ſulphur which fly off. When the maſs cools, it becomes ſolid and black. The charcoal in decompoſing the ſulphuric acid of the ſulphate of ſoda, ſets the ſulphur free, which combines with the lime of the carbonate of lime, and is partly ſublimed; while a part of the carbonic acid combines with the ſoda; ſo that the product is a mixture of carbonate of ſoda, of lime and charcoal, analogous to the ſoda of commerce. In this way 0.58 of crude ſoda may be extracted. Other acids, as well as the ſulphuric, ſuch as the acetic, the phoſphoric, and boracic, have been propoſed to be employed with the ſame view; or indeed, any acid which has a ſtronger affinity for the ſoda than the muriatic acid, and is not decompoſed with much difficulty.

10. But theſe proceſſes are not ſufficiently economical to anſwer the purpoſes of the manufacturer: Other proceſſes have, therefore, been propoſed and tried with the ſame view; but ſcarcely any has ſucceeded. This ſalt is very readily decompoſed by barytes or potaſh, which combines with the muriatic acid, and ſets the ſoda free; but the expence of preparing theſe ſubſtances far exceeds the price of the ſoda in the market, ſo that they cannot be employed to advantage.

1057 By lime

It has been propoſed to decompoſe ſea ſalt by means of lime, for obtaining the ſoda. Soda is ſeparated from the acid by mixing the common ſalt with lime, in the form of paſte, and by expoſing it to moiſture. In a ſhort time the ſoda appears on the ſurface in the ſtate of effloreſcence. Scheele, it is obſerved by Berthollet, was the firſt who noticed the decompoſition of the muriate of ſoda by means of lime. He explains this decompoſition by ſhowing, that lime acts on ſalts with fixed alkaline baſes. It decompoſes a ſmall part of the muriate of ſoda, with which it is in contact, and the ſoda eliminated by this means, combines with the carbonic acid of the atmoſphere. The carbonate of ſoda effloreſces, ſo that it oppoſes all reſiſtance to the action of the lime, and the decompoſition of the muriate of ſoda continues until it is impeded by the quantity of muriate of lime formed. It is in this way that the ſame philoſopher accounts for the formation of ſoda in the ſoil of Egypt. The circumſtances neceſſary for this are, 1ſt, A ſand containing a great quantity of carbonate of lime; 2d, moiſture; and 3d, muriate of ſoda: and theſe circumſtances are found to exiſt in thoſe places where there is an abundant production of ſoda *. A manufactory for the purpoſe of extracting ſoda from ſea ſalt, by means of lime, was eſtabliſhed in France by Guyton.

1058 By lead.

11. Common ſalt is decompoſed for the purpoſe of obtaining the ſoda, by means of litharge. In a mixture of four parts of litharge, and one of ſea ſalt, with a little water, in the courſe of a few hours, a decompoſition of the ſalt is effected. The muriatic acid of the ſalt combines with the lead, and is precipitated; while the ſoda remains in the ſolution, from which it may be ſeparated by filtration and evaporation.

1059 By iron.

It has been found too, that ſea ſalt may be decompoſed by other metallic ſubſtances. Scheele obſerved, that iron produced this effect. By dipping a plate of iron in a ſolution of ſalt, and expoſing it in a moiſt place, it was incruſted with ſoda. From other experiments it appears, that this decompoſition may be effected by means of copper and zinc.

1060 Compoſition.

12. Muriate of ſoda, according to Bergman, is compoſed of

Acid	52
Soda	42
Water	6
	100

According to Kirwan, when dried in the temperature of 80°, it is compoſed of

Acid	38.88
Soda	53.00
Water	8.12
	100.00

1061 Uſes.

13. Common ſalt may be regarded almoſt as a neceſſary of life. It is the moſt uſeful of all ſubſtances for the preſervation of animal matters which are intended for food. It is probable that it is highly uſeful, not merely as a ſeaſoning for food, of which it is one of the moſt agreeable, but alſo to promote its digeſtion. It is alſo employed in many arts, as in metallurgy, in dyeing, and in the enamelling of ſtoneware.

6. Hyperoxymuriate of Soda.

1062 Preparation.

1. This ſalt is prepared in the ſame manner as the combination of this acid with potaſh. It is, however, difficult to obtain it pure, as it has nearly the ſame degree of ſolubility in water as the muriate of ſoda. It is ſoluble in three parts of cold and leſs of warm water. It is alſo ſoluble in alcohol, and it ſeems to communicate a greater degree of ſolubility to the muriate of ſoda.

1063 Properties.

2. The cryſtals of this ſalt are in the form of cubes, or in rhomboids. It produces the ſenſation of cold in the mouth, and its taſte is eaſily diſtinguiſhed from muriate of ſoda. It is decompoſed by heat, by combuſtible bodies, and by acids, in the ſame manner as the hyperoxymuriate of potaſh.

1064 Compoſition.

3. This ſalt is compoſed of

Hyperoxymuriatic acid	66.2
Soda	29.6
Water	4.2
	100.0 *

7. Fluate of Soda.

1065 Preparation.

1. This ſalt, which is a compound of fluoric acid and ſoda, is formed by ſaturating the acid with the alkali. If the ſolution be evaporated till a pellicle appears, cryſtals of fluate of ſoda are obtained.

1066 Properties.

2. Theſe cryſtals are in the form of ſmall cubes, have a bitter and aſtringent taſte, are not deliqueſcent, and not very ſoluble in water. They decrepitate on hot charcoal, and melt before the blow-pipe into a ſemitranſparent globule.

3. The concentrated acids diſengage the fluoric acid with effervеſcence. This ſalt is alſo decompoſed by limewater, barytes, and magneſia.

8. Borate of Soda.

1. This ſalt, a compound of the boracic acid and ſoda, is formed by ſaturating the acid with the alkali; but nothing is known of its nature and properties. The ſpecific gravity is 1.1351. But the combination of ſoda with this acid, which is a natural production, has been particularly examined.

Sub-borate of Soda, or Borax.

1067 Hiſtory.

1. This ſubſtance has been long known. Indeed it is ſuppoſed, that the ancients were acquainted with it, and that they employed it for ſeveral purpoſes, under the name of *chryſocolla* which is mentioned by Pliny. It received this name from them, it is ſuppoſed, from knowing its property of ſoldering gold and the other metals. The name borax is derived from ſome of the oriental languages. Although borax was the ſubject of reſearch among the alchemiſts and earlier chemiſts, yet nothing was known of its nature and compoſition, till the beginning of the 18th century. It was then decompoſed by Homberg, by expoſing it to heat with ſulphate of iron. The acid was ſeparated by ſublimation, and long after known by the name of the *ſedative ſalt of Homberg*. In 1732 its real compoſition was diſcovered by Geoffroy. He obtained the acid cryſtallized in the humid way. In 1748 Baron decom-

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* *Reſearches*, p. 59, and 112.

* *Phil. Tranſ.* 1802, p. 144.

poſed borax by means of the vegetable acids, and he completed the knowledge of its compoſition, by forming it with the acid and the alkali. Bergman afterwards ſhewed, that borax is a ſalt with exceſs of ſoda; and to be neutralized, it requires one half of its weight of boracic acid.

2. Borax is a natural production of the earth in many parts of the world. It is formed at the bottom of ſome lakes in Perſia, the Mogul territory, in Thibet, in China and Japan. It has been alſo found in ſome lakes in Tuſcany. In the Eaſt Indies it is known under the name of *tincal*, and in commerce under that of *crude borax*. In this ſtate the borax is in the form of ſmall, ſemitranſparent, greeniſh cryſtals, intermixed with a greaſy matter, of a dirty gray colour, and of a ſweetiſh alkaline taſte.

1068 Purification. 3. The purification of borax was originally in the hands of the Venetians; but it has ſince been practiſed, and now almoſt excluſively, by the Dutch. Their proceſs is not exactly known. Valmont-Bomare, who viſited one of theſe places in Holland, ſays, that 80 parts of purified borax are obtained from 100 of the crude materials; and to extract the ſalt completely, from eight to twelve ſolutions and cryſtallizations are neceſſary; that all the veſſels employed in the purification of this ſalt, are either of lead, or covered with lead: but he adds, that one part of the proceſs was concealed from him, and he ſuſpects that lime-water may have been employed in this part of the proceſs.

1069 Properties. 4. Borax, after being thus purified, is in the form of compreſſed ſix-ſided priſms with three-ſided ſummits. The taſte is ſweetiſh, and perceptibly alkaline. It changes the vegetable blues to a green colour. The ſpecific gravity is 1.742. It effloreſces ſlightly in the air, and is ſoluble in water. Twelve parts of water of the temperature of 60° diſſolve one of borax. Six parts are only neceſſary at the boiling temperature.

1070 Action of heat. 5. When borax is expoſed to heat, it readily melts. As the water of cryſtallization flies off, it ſwells up and acquires a greater bulk, and aſſumes the form of a porous maſs. By this proceſs it loſes more than one-third of its weight, and in this ſtate it is called *calcined borax*. When it is expoſed to a red heat, it is converted into a tranſparent glaſs, which is ſoluble in water.

1071 Of acids. 6. Borax is decompoſed by all the acids which have a ſtronger affinity for the ſoda. It is by means of the ſulphuric and the nitric acids, that boracic acid is obtained from borax.

1072 Compoſition. 7. The component parts of borax, according to Kirwan, are

Boracic acid	36
Soda	17
Water	47
	100

It is ſuppoſed that only five parts of the ſoda are ſaturated with the acid, and that the other twelve parts form the exceſs of alkali which is contained in the ſalt.

1073 Uſes. 8. Borax is much employed in the arts, as a flux for metals, and to promote the ſoldering of the more precious metals. It is alſo employed by the mineralogiſt as a flux for treating minerals by the blow-pipe. Calcined borax is employed in medicine as an abſorbent *.

9. Phoſphate of Soda.

1074 Hiſtory. 1. This compound of phoſphoric acid and ſoda, was the firſt diſcovered of the combinations of phoſphoric acid. Margraaff was the firſt who extracted it from human urine, then in combination with ammonia, forming a triple ſalt, which was known by the name of *fuſible* or *microcoſmic ſalt*. Haupt afterwards obtained it ſeparate, and diſtinguiſhed it by the name of *ſal mirabile perlatum*, or wonderful perlated ſalt, on account of its pearl-like colour. At laſt the younger Rouelle diſcovered that ſoda was one of its conſtituent parts. By ſome it was ſuppoſed, that the acid was different from the phoſphoric, becauſe no phoſphorus could be obtained from it. To this acid Bergman gave the name of perlated acid; but by the analyſis of Klaproth, it was proved that this ſalt conſiſts of phoſphoric acid and ſoda, with an exceſs of acid.

1075 Preparation. 2. This ſalt is prepared by ſaturating the liquid acid phoſphate, which is obtained from burnt bones by means of the ſulphuric acid, with carbonate of ſoda, which muſt be added in exceſs. The carbonate and a little phoſphate of lime are precipitated in the ſolution, which muſt be filtered and evaporated till a thin pellicle appears on the ſurface. The phoſphate of ſoda is cryſtallized by cooling. Or it may be obtained by the direct combination of phoſphoric acid and ſoda, which muſt alſo be added in exceſs.

1076 Properties. 3. The phoſphate of ſoda cryſtallizes in lengthened rhomboids whoſe angles are often truncated, and ſometimes it affords rhomboidal priſms, and ſeveral other varieties. The exceſs of ſoda is neceſſary, to make it aſſume a regular form, and thus it changes vegetable blues to a green. The ſpecific gravity is 1.33. It has a ſweetiſh, ſaline taſte, ſimilar to that of common ſalt.

1077 Action of water. 4. It effloreſces in the air, and is very ſoluble in water. Four parts of water at the temperature of 60°, and one half its weight of boiling water, are ſufficient to diſſolve it.

1078 Of heat. 5. The phoſphate of ſoda expoſed to heat, undergoes the watery fuſion. In a red heat it melts, and is converted on cooling, into a milky white glaſs. By the action of the blow-pipe on charcoal, it melts into a globule which is tranſparent while it is hot, but becomes opaque on cooling, and aſſumes the polyhedral form when it becomes ſolid.

1079 Of acids. 6. The ſulphuric, nitric, and muriatic acids decompoſe it partially, and convert it into the acidulous phoſphate of ſoda.

1080 Uſes. 7. Since the properties of this ſalt were diſcovered, it has become an object of conſiderable importance, on account of the various uſes to which it has been applied. It was introduced into medicine by Dr Pearſon, and is found to be a mild laxative, particularly agreeable on account of its taſte, as it may be taken in broth, as a ſubſtitute for common ſalt. It is employed by mineralogiſts as a teſt for the fuſion of mineral ſubſtances by the blow-pipe, and in ſoldering, as a cheap ſubſtitute for borax.

10. Phoſphite of Soda.

1081 Preparation. 1. This compound of phoſphorous acid and ſoda, may be formed by the direct union of the acid and alkali in ſolution; and by evaporation cryſtals may be obtained.

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* Fourcroy Connaiſs. Chim. iii. p. 325.

1082 Properties. 2. This ſalt cryſtallizes ſometimes in four-ſided priſms with unequal faces; ſometimes in long rhomboids, or in the form of feathers. The taſte is cool and ſweetiſh. It effloreſces in the air, and is ſoluble in two parts of cold water, and little more ſoluble in warm water; ſo that it cryſtallizes by evaporation rather than in cooling.

1083 Action of heat. 3. It melts readily under the blow-pipe, gives out fine phoſphoric light, and is converted into a glaſs which continues tranſparent while it is hot, but becomes opaque when it cools.

1084 Compoſition. 4. The component parts of this ſalt are,

Phoſphorous acid	16.3
Soda	23.7
Water	60.0
	100.0

5. This ſalt is eaſily decompoſed by lime, barytes, and magneſia. It decompoſes the ſulphates, nitrates, and muriates of lime, of barytes, ſtrontites, and magneſia. It has not yet been applied to any uſe.

11. Carbonate of Soda.

1085 Hiſtory. 1. This ſalt, which is a compound of carbonic acid and ſoda, was long applied to various uſes, before its nature and compoſition were known; nor was it perfectly underſtood till the diſcovery of Dr Black, which ſhewed the two ſtates in which the alkali exiſts; in the cauſtic or pure ſtate, and in the mild ſtate, when it is combined with fixed air, or carbonic acid. The different names under which it is known, have been already mentioned in treating of ſoda. It is found in great abundance in Egypt, where it effloreſces on the ſoil, and is diſtinguiſhed by the name of *natron*. In a ſimilar ſtate of efflorеſcence, the carbonate of ſoda is found in ſubterraneous places, and the walls of buildings; but it is chiefly extracted, as has been already obſerved, from ſea-plants, eſpecially from thoſe which belong to the genus of *fuci*.

1086 Preparation. 2. Carbonate of ſoda may be obtained by diſſolving a quantity of the ſoda of commerce with three or four times its weight of pure cold water, and then by filtering the liquor, and evaporating till a ſlight pellicle is formed. This pellicle, which conſiſts of ſmall cubes of common ſalt, is to be removed. The heat is to be continued as long as any pellicle is formed, after which the liquid is ſet by to cool, and the carbonate of ſoda cryſtallizes.

1087 Properties. 3. The form of the cryſtals of carbonate of ſoda are irregular or rhomboidal octahedrons, formed by two quadrangular pyramids, truncated near the baſe, which exhibits dicahedral ſolids, with two acute and two obtuſe angles. The taſte is ſlightly acrid; it converts vegetable blues to a green colour, and its ſpecific gravity is 1.3591.

1088 Action of water. 4. The carbonate of ſoda effloreſces very rapidly in the air. It is ſoluble in two parts of cold, and little more than its weight of boiling water. It cryſtallizes on cooling; but to obtain regular cryſtals, the evaporation muſt be ſlow and ſpontaneous.

1089 Of heat. 5. When expoſed to heat, it undergoes the watery fuſion, and if the heat be continued, it paſſes into the igneous fuſion. It is ſomewhat more fuſible than the carbonate of potaſh, which renders it preferable in the manufacture of glaſs.

6. In its decompoſition by other ſubſtances, it is exactly ſimilar to the carbonate of potaſh.

1090 Compoſition. 7. The component parts of carbonate of ſoda are according to

	Bergman.	Kirwan. In cryſtals.	Kirwan. Dry.
Carbonic acid	16	14.42	40.05
Soda	20	21.58	59.86
Water	64	64.00	00.00
	100	100.00	99.91

12. Arſeniate of Soda.

1. This is the compound of the arſenic acid with ſoda; and when the acid is ſaturated with the alkali, the ſalt cryſtallizes.

2. According to Scheele the form of the cryſtals of this ſalt is like thoſe of the acidulous arſeniate of potaſh. Pelletier obſerves that the arſeniate of ſoda cryſtallizes in ſix-ſided priſms, terminated by planes perpendicular to their axis. In other reſpects it is ſimilar to the arſeniate of potaſh, being decompoſed by charcoal, by the acids and the earths. With an exceſs of acid, it does not cryſtallize, but becomes deliqueſcent.

13. Tungſtate of Soda.

1091 Preparation. 1. This ſalt, which is the compound of tungſtic acid and ſoda, may be formed by diſſolving the oxide of tungſten in a ſolution of pure ſoda, or carbonate of ſoda. By evaporating the ſolution, cryſtals of tungſtate of ſoda are obtained.

1092 Properties. 2. The cryſtals of this ſalt are in the form of elongated, ſix-ſided plates. The taſte is acrid and metallic. It is ſoluble in four times its weight of cold water; and boiling water diſſolves one half of its weight. It reſtores the colour of turnſole which has been reddened by an acid.

1093 Action of acids. 3. This ſalt is decompoſed by the ſulphuric, nitric, muriatic, acetic, and oxalic acids. They form a white triple ſalt, which is alſo produced by lime water. The phoſphoric acid produces no change, and if the ſulphuric acid be afterwards added, it no longer cauſes a precipitate. The tungſtate of ſoda is not decompoſed by the ſulphate of potaſh or of magneſia. The muriates of lime and barytes occaſion a white precipitate. The ſolution of tin, and all other metallic ſolutions, alſo decompoſe it *.

14. Molybdate of Soda.

15. Chromate of Soda.

The chromic acid combines with ſoda, and forms a ſalt, the cryſtals of which are of an orange colour, but its other properties are unknown.

16. Columbate of Soda.

Columbic acid enters into combination with ſoda, but little is known of its properties.

17. Acetate of Soda.

1094 Preparation. 1. The combination of the acetic acid with ſoda was formerly known by the name of *cryſtallized foliated earth.* This ſalt is prepared by ſaturating the acetic acid with carbonate of ſoda. The ſolution is then filtered, and evaporated till a ſlight pellicle appear on the ſurface; and when it is ſet by to cool, cryſtals are depoſited.

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* *Jour. de Mines*, N° 19. p. 21.

1095 Properties. 2. The cryſtals of acetate of ſoda are in the form of ſtriated priſms, like thoſe of ſulphate of ſoda. It has a bitter, pungent taſte, is not deliqueſcent in the air, and is ſoluble in about three parts of cold water. The ſpecific gravity is 2.1. When expoſed to heat it is decompoſed, being firſt deprived of its water of cryſtallization. After diſtillation, the reſiduum has the property of phoſphorus. It is decompoſed by barytes and potaſh *.

18. Oxalate of Soda.

The oxalic acid is capable of forming an acidulous ſalt with ſoda; but when it is fully ſaturated, the oxalate of ſoda, thus formed, is difficult of cryſtallization. If two parts of cryſtallized carbonate of ſoda are diſſolved in one part of oxalic acid, part of the oxalate of ſoda is precipitated, and what remains in the ſolution, being evaporated, affords cryſtals in the form of ſmall grains. This ſalt is more ſoluble in warm than in cold water, and gives a green colour to the ſyrup of violets. It is decompoſed by potaſh. In other reſpects it reſembles the oxalate of potaſh.

19. Tartrate of Soda.

This compound of tartaric acid and ſoda, is formed by ſaturating the acid with the alkali. The form of the cryſtals of this ſalt is that of fine needles. The ſpecific gravity is 1.7437. This ſalt combines with another portion of acid, and forms an acidulous tartrate or ſupertartrate of ſoda, which is not more ſoluble in water than the acidulous tartrate of potaſh.

20. Citrate of Soda.

1. This ſalt, which is a compound of citric acid and ſoda, is formed by directly combining the acid and alkali.

2. It cryſtallizes in ſix-ſided priſms which are not terminated by a pyramid. It has a ſaline taſte, effloreſces in the air, and is ſoluble in two parts of water. When heated it boils up, ſwells, and is charred. It is decompoſed by barytes and lime water. It is compoſed of

Acid	60.7
Soda	39.3
	100.0

21. Malate of Soda.

This ſalt, formed of malic acid and ſoda, is deliqueſcent in the air, and very ſoluble in water. Its other properties are unknown.

22. Gallate of Soda.

The nature of the compound of gallic acid with ſoda has not yet been aſcertained. A green colour is produced, when the alkali is dropt into the acid.

23. Benzoate of Soda.

The compound of benzoic acid with ſoda, forms a ſalt which readily cryſtallizes. It is deliqueſcent in the air, and very ſoluble in water. The taſte is ſharp and ſaline. This ſalt exiſts ready formed in the urine of graminivorous animals.

24. Succinate of Soda.

The combination of ſuccinic acid with ſoda, forms beautiful tranſparent cryſtals by ſpontaneous evaporation. The cryſtals are in the form of four-ſided priſms with two-ſided ſummits. The taſte of this ſalt is bitter. It is not deliqueſcent in the air, and it requires about three times its weight of water to diſſolve it. It is decompoſed when it is expoſed to heat in cloſe veſſels.

25. Saccolate of Soda.

All that is known of this ſalt is, that it cryſtallizes in ſmall cryſtals, and is ſoluble in five times its weight of boiling water.

26. Camphorate of Soda.

1. This compound of camphoric acid with ſoda is formed by ſaturating a ſolution of carbonate of ſoda in water with the acid; and by evaporation with a gentle heat, the cryſtals are obtained, when the ſolution cools.

2. The cryſtals of camphorate of ſoda are irregular. They are white and tranſparent. The taſte is bitter. Expoſed to the air, this ſalt effloreſces. It is ſoluble in eight parts of boiling water.

3. Expoſed to heat, it melts and ſwells, and the acid is diſſipated in thick vapours of an aromatic odour. With the blow-pipe it burns with a blue flame, and is decompoſed. The acid is ſublimed, and the alkali remains behind. It is decompoſed by potaſh, and by the ſtrong acids *.

27. Suberate of Soda.

The compound of ſuberic acid with ſoda, forms a ſalt which does not cryſtallize. It has a ſlightly bitter taſte, and reddens the tincture of turnſole. It deliqueſces in the air, and is very ſoluble in water. Expoſed to heat, it ſwells and melts; the acid is ſublimed, and the alkali remains behind. The mineral acids decompoſe it, and it is alſo decompoſed by the calcareous, aluminous and magneſian ſalts †.

28. Mellate of Soda.

The compound of mellitic acid with ſoda, when it is ſaturated, forms cryſtals in cubes or three-ſided tables. Sometimes they are formed in groups, and ſometimes they are inſulated.

29. Lactate of Soda.

All that is known of this ſalt is, that it does not cryſtallize, but is ſoluble in alcohol.

30. Pruſſiate of Soda.

This ſalt, which is a compound of pruſſic acid and ſoda, is very ſoluble in water, converts vegetable blues to green, and when it is expoſed to a very moderate heat, it is partially decompoſed.

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* Fourcroy Connaiſs. Chim. viii. p. 198.

* Ann. de Chim. xxvii. p. 28.

† Ibid. xxiii. p. 53.

31. Sebate of Soda.

Nothing farther is known of the compound of ſebacic acid with ſoda, than that it is ſoluble in water.

IV. Compounds of Soda with Inflammable Subſtances.

1. Soda enters into combination with alcohol, and forms a reddiſh coloured acrid ſolution; but when heat is applied to this ſolution, it appears that the alcohol is partially decompoſed.

2. There is no action between ether and ſoda.

3. Soda readily combines with the fixed oils, and eſpecially that claſs of them called *fat oils*, and forms with them compounds called ſoaps.

4. Soda combines in very ſmall quantity with the volatile oils, and the compounds thus formed have ſome of the properties of ſoap.

SECT. III. *Of AMMONIA and its Combinations.*

1096 History. 1. This ſubſtance has been long known under the names of *volatile alkali*, *volatile ſpirit of ſal ammoniac*, *cauſtic volatile alkali*, *hartſhorn*, *ſpirit of hartſhorn* and *of urine*, becauſe it was obtained from theſe ſubſtances. It has received the name *ammonia* from *ſal ammoniac*, a ſalt which was extracted from the urine and dung of camels, collected near the temple of Jupiter Ammon in Africa. This ſalt was unknown to the ancients. It is firſt mentioned by Baſil Valentine, who lived in the 15th century, as being prepared from certain ſubſtances, with an account of ſome of its properties. But the difference between the pure ſalt and its compound with carbonic acid was not known till the diſcovery of Dr Black. It was ſuppoſed to be in the ſtate of greateſt purity in the ſolid and cryſtalline form; and in its pure, cauſtic, and liquid ſtate, it was ſuppoſed to be changed, and contaminated with the lime or the different matters which had been employed in extracting it from ſal ammoniac. It was afterwards examined by Dr Prieſtley in the ſtate of gas, and he decompoſed it by electricity, but without diſcovering its conſtituent parts. This was at laſt effected by the reſearches and experiments of Scheele and Bergman, and finally confirmed by thoſe of Berthollet.

1097 Preparation. 2. Ammonia may be obtained by the following proceſs. Three parts of quicklime, and one part of ſal-ammoniac reduced to powder, are to be put into a retort, and the beak of the retort immerſed under mercury in the mercurial apparatus. A jar filled with mercury is inverted above it. Heat is applied to the retort, and a gas comes over in great abundance. This gas is *ammonia* or *ammoniacal gas*. Sal-ammoniac conſiſts of muriatic acid and ammonia. The affinity of lime for muriatic acid is ſtronger than that of ammonia, and therefore the ammonia is diſengaged in the ſtate of gas, while the lime combines with the acid. The gas muſt be received over mercury, becauſe it is readily abſorbed by water.

1098 Properties. 3. Ammonia in the ſtate of gas reſembles common air. It is tranſparent and colourleſs, and may be indefinitely compreſſed and dilated. The ſmell is extremely pungent and acrid, particularly irritating the eyes and noſtrils. It has an acrid and cauſtic taſte, but is much leſs corroſive than the other alkalies. It changes vegetable blues to a green colour. It is lighter than common air. Its ſpecific gravity is 0.000732; ſo that it is nearly one half lighter. According to Mr Kirwan, a cubic inch of this gas weighs only .27 of a grain.

It is totally unfit for reſpiration. No animal can breathe it without inſtant death. It is alſo unfit for the ſupport of combuſtion; but although it extinguiſhes burning bodies, the flame of a candle let down into this gas, is conſiderably enlarged in volume by the addition of another flame, which is of a pale yellow colour.

1099 Action of heat. 4. This gas is unaltered by the action of light. When it is expoſed to a ſtrong heat, as when it is paſſed through a red-hot porcelain tube, it is decompoſed and converted into azotic and hydrogen gaſes. It is alſo decompoſed by the electric ſpark. When it is expoſed to the temperature of —45°, it is condenſed, and aſſumes a liquid form; but it returns to the gaſeous ſtate by an elevation of temperature.

1100 Of oxygen. 5. There is no action between oxygen gas and this gas in the cold; but if the two gaſes mixt together are made to paſs through a red-hot porcelain tube, the ammonia is decompoſed; a detonaton takes place, the hydrogen combines with the oxygen and forms water. The azote paſſes off in the ſtate of gas.

1101 Common air. 6. There is no action between this gas and azotic gas, nor is there any action between common air and ammoniacal gas in the cold; but if the mixture be made to paſs through a red-hot porcelain tube, water is formed, and the gas which eſcapes is a combination of the azotic gas of the atmoſphere, and of that which entered into the compoſition of ammonia. But if the ſame experiment be made with a greater proportion of oxygen gas, the product is nitric acid, which is formed by the combination of part of the oxygen and the azote *.

1102 Composition. 7. It has been already mentioned, that the conſtituent parts of ammonia were diſcovered by Scheele and Bergman, and Prieſtley and Berthollet. According to the experiments of the latter, ammonia is compoſed of 121 parts of azote, and 29 of hydrogen. This reſult was obtained by decompoſing the ammonia by means of electricity. One hundred parts of ammonia, therefore, are compoſed of

Azote	80
Hydrogen	20
	100

1103 Of water. 8. Ammoniacal gas combines very rapidly with water. If a bit of ice be brought into contact with this gas, it abſorbs and condenſes it, and inſtantly becomes liquid. There is at the ſame time a production of cold; but water in the liquid ſtate, as it abſorbs this gas, becomes warm, becauſe the gas is deprived of that quantity of caloric which is neceſſary to retain it in the gaſeous form. The water, as it abſorbs the gas, becomes ſpecifically lighter. When water is ſaturated with this gas, it is known under the name of liquid ammonia. The ſpecific gravity of a ſaturated ſolution is 0.9054. When this ſolution is expoſed to the temperature of 130° the ammonia is driven off, and aſſumes the gaſeous form; and when it is ſlowly and gradually cooled to the temperature of from —35 to —42°*,

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* Fourcroy Connaiſs. Chim. ii. p. 430.

—42°, it cryſtallizes; but when the temperature is rapidly diminiſhed to —58° it aſſumes the form of jelly. At that temperature it has no ſmell †.

By Mr Davy's experiments, a ſaturated ſolution of ammonia contains, in 100 parts,

Water	74.63
Ammonia	25.37
	100.00

He has alſo aſcertained the different proportions of water and ammonia which are contained in 100 parts of liquid ammonia of different ſpecific gravities ‡. Theſe are exhibited in the following table.

Table of the quantities of Ammonia, ſuch as exiſts in the aëriform ſtate, ſaturated with water at 52°, in Aqueous ammoniacal Solutions of different ſpecific gravities.

100 Specific gra.		Ammoniac.	Water.
9054	contain	25,37	74,63
9166		22,07	77,93
9255		19,54	80,46
9326		17,52	82,48
9385		5,88	84,12
9435		14,53	85,47
9476		13,46	86,54
9513		12,40	87,60
9545		11,56	88,44
9573		10,82	89,18
9597		10,17	89,83
9619		9,60	90,40
9684		9,50	90,5
9639		9,09	90,91
9713		7,17	92,83

1104 Affinities. 9. The order of affinities of ammonia is the ſame as the fixed alkalies.

I. Action of Phoſphorus on Ammonia.

1105 With heat. 1. There is no action between ammonia and phoſphorus in the cold; but when the two gaſes are paſſed through a red-hot porcelain tube, the ammonia is decompoſed, and its conſtituent parts enter into combination with the phoſphorus. There is formed phoſphorated hydrogen gas, and phoſphorated azotic gas. In this caſe, there is a double action of the phoſphorus, one part combining with the hydrogen, and another with the azote.

2. Ammonia is alſo decompoſed by red-hot charcoal, when it paſſes over in the ſtate of gas at this temperature. Part of the carbone of the charcoal combines with the ammonia, and forms pruſſic acid.

II. Action of Sulphur on Ammonia.

1. Ammonia combines with ſulphur in the ſtate of vapour. This combination conſtitutes a ſulphuret of ammonia, which has the property of decompoſing water, and is then converted into a hydrogenated ſulphuret of ammonia. This may be prepared by diſtilling in a retort, a mixture of muriate of ammonia, lime, and ſulphur. By this proceſs a liquid of a deep orange colour, which exhales extremely fetid vapours, on account of the exceſs of ammonia which it contains, is produced. This was known under the name of the *fuming liquor of Boyle*. This ſulphuret is decompoſed by heat, by the acids and ſulphurated hydrogen gas.

2. When ammonia abſorbs ſulphurated hydrogen gas, either by agitating the gas in a veſſel with liquid ammonia, or by paſſing a current of the gas through it, there is an evolution of caloric and the formation of vapour, and the liquid is converted into an orange colour. This is the hydroſulphuret of ammonia. It has no longer the fetid odour of the hydrogenated ſulphuret, and it may be cryſtallized. It is decompoſed by the action of heat, by the acids, and by the metallic oxides.

III. Compounds of Ammonia with the Acids.

1. Sulphate of Ammonia.

1106 Hiſtory. 1. The compound of ſulphuric acid with ammonia was formerly called *ſecret ſal ammoniac of Glauber*, becauſe it was diſcovered by that chemiſt. It was alſo called *vitriolated ammonia*, and *vitriolated volatile alkali*. It was diſcovered by Glauber in examining the reſiduum of the decompoſition of ammonia by means of ſulphuric acid.

1107 Preparation. 2. This ſalt may be formed by ſaturating the acid with the alkali, and afterwards cryſtallizing it.

1108 Properties. 3. The cryſtals of ſulphate of ammonia are ſix-ſided priſms with unequal ſides, terminated by ſix-ſided pyramids. The ſulphate of ammonia undergoes little change in the air. It ſlowly attracts moiſture in a humid atmoſphere. It is ſoluble in two parts of cold water, and in a ſimilar quantity of boiling water.

1109 Action of heat. 4. When expoſed to heat, it melts; and if the heat be continued, it loſes a part of its baſe, and is converted into the acidulous ſulphate of ammonia. This differs from the ſulphate by its ſharp taſte, and its property of reddening vegetable blues, greater ſolubility, and a different action on ſeveral compounds.

5. This ſalt is not decompoſed like the other ſulphates, on account of its greater volatility. The component parts of this ſalt, according to Mr Kirwan, are,

Acid	54.66
Ammonia	14.24
Water	31.10
	100.00

2. Sulphite of Ammonia.

1110 Preparation. 1. The compound of ſulphurous acid with ammonia is prepared by paſſing a ſtream of ſulphurous acid gas into a veſſel with liquid ammonia. The gaſeous acid is readily abſorbed, much heat is produced, and the ſulphite of ammonia cryſtallizes on the cooling of the ſaturated ſolution.

1111 Properties. 2. This ſalt is in the form of ſix-ſided priſms terminating in ſix-ſided pyramids, or in that of four-ſided rhomboidal priſms, with three-ſided ſummits. The taſte is at firſt cool and pungent, and afterwards ſulphurous. It is deliqueſcent in the air, from which it abſorbs oxygen, and is converted into the ſulphate. It is ſoluble in its own weight of cold water. The ſolution

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† Ann de Chim. xxix p 289.

‡ Davy's Reſearches, p. 68.

produces a great degree of cold. Boiling water diſſolves ſtill more. Water ſaturated with ſulphite of ammonia, and agitated in the open air, preſents this ſalt in a few hours converted into the ſulphate, without any cruſt on the ſurface, or muddineſs in the liquid, becauſe it is very ſoluble in water.

3. It decrepitates ſlightly on red-hot coals: when it is gradually heated in a cloſe veſſel, it gives out at firſt water and ammonia, and then ſublimes totally in the ſtate of acidulous ſulphite.

1112 Compoſition. 4. The conſtituent parts of this ſalt are,

Sulphurous acid	60
Ammonia	29
Water	11
	100

3. Nitrate of Ammonia.

1113 Hiſtory. 1. This compound of nitric acid and ammonia was formerly called *nitrous ſal ammoniac*, *inflammable nitre*. This ſalt has been particularly examined by Berthollet, and more lately by Mr Davy.

1114 Preparation. 2. Nitrate of ammonia is prepared by directly combining the acid and the alkali, and it may be obtained in cryſtals by careful evaporation and ſlow cooling.

1115 Properties. 3. This ſalt cryſtallizes in ſix-ſided priſms, terminating in long ſix-ſided pyramids; but the appearance of the cryſtals varies with the temperature in which the evaporation goes on. Sometimes they are in long ſilky threads, ſoft and elaſtic; the taſte is very acrid, bitter, and penetrating; and the ſpecific gravity is 1.5785.

1116 Action of water. 4. When the nitrate of ammonia is expoſed to the air, it attracts moiſture, and deliqueſces. It is ſoluble in two parts of cold water. Boiling water diſſolves double of its own weight.

1117 Of heat. 5. Nitrate of ammonia very readily undergoes the watery fuſion. If the heat be continued, it is entirely deprived of its water of cryſtallization; and when the temperature is increaſed, it explodes ſpontaneouſly, giving out at the ſame time a brilliant white flame, with conſiderable noiſe; it is then entirely diſſipated into vapour. This detonation inſtantaneouſly takes place, when the nitrate of ammonia is thrown on a red-hot iron. It was from this property that the ſalt derived its name of *inflammable nitre*. The nature of this rapid combuſtion will be underſtood by conſidering the component parts of the ſalt. The hydrogen of the ammonia enters into combination with the oxygen of the acid; water is formed, and azotic gas is diſengaged from each of the component parts of the ſalt. In the different ſtates of cryſtallization, this ſalt requires different temperatures for its fuſion and decompoſition. The following are the concluſions from Mr Davy's experiments.

" *a*. Compact or dry nitrate of ammonia undergoes little or no change at temperatures below 260°.

" *b*. At temperatures between 275° and 300°, it ſlowly ſublimes without decompoſition, or without becoming fluid.

" *c*. At 320° it becomes fluid, decompoſes, and ſtill ſlowly ſublimes; it neither aſſuming, nor continuing in, the fluid ſtate, without decompoſition.

" *d*. At temperatures between 340° and 480°, it decompoſes rapidly.

" *e*. The priſmatic and fibrous nitrates of ammonia become fluid at temperatures below 300°, and undergo ebullition at temperatures between 360° and 400°, without decompoſition.

" *f*. They are capable of being heated to 430° without decompoſition or ſublimation, till a certain quantity of their water is evaporated.

" *g*. At temperatures above 450°, they undergo decompoſition without previouſly loſing their water of cryſtallization *."

1118 Compoſition. 6. The component parts of nitrate of ammonia are, according to.

	Kirwan,	Fourcroy,
Acid,	57	46
Ammonia,	23	40
Water,	20	14
	100	100

Mr Davy has aſcertained the proportions of the component parts of this ſalt in its three different ſtates †.

	Fibrous.	Priſmatic.	Compact.
Acid,	72.5	69.5	74.5
Ammonia,	19.3	18.4	19.8
Water,	8.2	12.1	5.7
	100.0	100.0	100.0

1119 Uſes. 9. This ſalt has been applied to no uſe, but for the purpoſes of chemical experiment, and eſpecially for the preparation of the nitrous oxide or gaſeous oxide of azote, which has been already deſcribed in treating of the compounds of azote.

4. Nitrite of Ammonia.

If this ſalt be formed by depriving the nitrate of ammonia of part of its acid, it muſt be extremely difficult, Fourcroy obſerves, to obtain it in this way, before the ſalt is totally decompoſed ‡.

5. Muriate of Ammonia.

1120 Hiſtory. 1. The compound of muriatic acid and ammonia has been known, from time immemorial, by the name o *ſal ammoniac*. It derives this name from Ammonia, a country of Libya, which name is deſcriptive of the ſandy ſoil of that region (A). Hence too is the origin of the epithet *Ammon* given to Jupiter, to whom a temple was erected in that country. This ſalt was originally collected in great quantities near this temple, where it was formed in the ſand from the excrementitious matters of different animals, particularly camels. It was well known to the Greeks and Romans, and was employed by them in ſeveral arts. Before the nature

* *Reſearches*, p. 85.

† *Ibid*, p. 72.

‡ *Connaiſs. Chim* iii. p. 160.

(A) From the Greek word αμμος, which ſignifies *ſand*.

ture of this ſalt was known, it was chiefly brought from Egypt; but it is now found to exiſt, ready formed, in different countries, particularly in the vicinity of volcanoes, where it ſeems to be ſublimed. It is found alſo in the mountains of Tartary and Thibet, in grottoes in the neighbourhood of Puzzuoli, and diſſolved in the waters of ſome lakes in Tuſcany. The nature of the muriate of ammonia was firſt diſcovered by Geoffroy; it was afterwards more accurately examined by Duhamel; and, at laſt, its properties were fully developed by Black, Bergman, and Scheele, Berthollet and Fourcroy.

1121 Purification.

2. The muriate of ammonia, which is found ready prepared in nature, is extremely impure. It muſt therefore be ſubjected to ſeveral proceſſes, to ſeparate the foreign matters with which it is impregnated. The ſalt which is found ſublimed in the crater of volcanoes, is generally mixed with arſenic and ſulphur. In Egypt it is prepared by collecting together the excrements of animals which feed on ſaline plants. Theſe ſubſtances are dried and burnt in furnaces which are conſtructed on purpoſe, or uſed as the common materials of fuel. The ſoot which is thus formed, is collected, and put into large glaſs bottles, and expoſed to a ſtrong heat, which is gradually increaſed for 72 hours. Towards the ſecond day the ſalt is ſublimed, and attaches itſelf to the upper part of the bottles. When the apparatus has cooled, the bottles are broken, and the ſalt in form of a cake is taken out, which amounts to little leſs than one-third of the ſoot which was employed. This manufacture is carried on at Grand Çairo; and the French conſul then reſident there, communicated an account of it to the Academy of Sciences, in the year 1719. But it was not till 40 years after this period that it was manufactured in Europe. The firſt manufactory was eſtabliſhed in Germany in 1759; others afterwards commenced in France, and in different parts of Britain.

In the European manufactories it is prepared by different proceſſes. Sometimes the calcareous muriate is precipitated by a carbonate of ammonia extracted from animal matters. After the lime is depoſited, the liquor is evaporated, and the muriate of ammonia is ſublimed. Sometimes too it is prepared by forming a ſulphate of ammonia; and by mixing the ſalt with a muriate of ſoda, and expoſing the mixture to heat, a double decompoſition is effected, and the muriate of ammonia is ſublimed. It is alſo prepared by the direct combination of muriatic acid and ammonia.

1122 Properties.

3. Prepared in this way by ſublimation, it is in the form of a ſolid maſs, which has ſome degree of elaſticity. It yields to the preſſure of the finger, may be compreſſed into a ſmaller bulk, and is with difficulty reduced to powder. The ſpecific gravity is 1.42. The taſte is pungent, acrid, and cooling. By ſolution in water and ſlow evaporation, it cryſtallizes in the form of long four-ſided pyramids. The primitive form of the cryſtal is the regular octahedon; and that of the integrant particle, the regular tetrahedron. Sometimes it cryſtallizes in cubes, and ſometimes the priſms are very ſmall, and grouped together, exhibiting a feathery appearance.

1123 Action of water.

4. The muriate of ammonia is not altered by expoſure to the air. It is ſoluble in three or four times its weight of cold water. Great cold is produced during the ſolution; and on this account it is employed with ſnow and ice in the production of artificial cold. Boiling water diſſolves nearly its own weight of this ſalt.

1124 Of heat.

5. The muriate of ammonia is fuſible and volatile. When it is thrown on red-hot coals, it is entirely diſſipated in white vapour. Expoſed to a high temperature, it is decompoſed.

1125 Of acids.

6. This ſalt is readily decompoſed by the ſulphuric acid, which diſengages the muriatic acid with violent efferveſcence. It is alſo decompoſed by the nitric acid, which oxygenates the muriatic acid. In this way a nitro-muriatic acid is prepared, which is employed for the ſolution of gold. Barytes, potaſh, ſoda, and lime, decompoſe the muriate of ammonia, and diſengage the ammonia in the ſtate of gas, merely by trituration; but if heat be applied, the decompoſition is more rapid and complete.

1126 Compoſition.

7. According to the analyſis of Mr Kirwan, the component parts of the muriate of ammonia are,

Acid,	42.75
Ammonia,	25.00
Water,	32.25
	100.00*

1127 Uſes.

8. No ſalt is more generally employed than muriate of ammonia. In chemiſtry it is uſed for the extraction of ammonia, and the carbonate of ammonia; for the production of cold, and as an inſtrument of analyſis. It is alſo employed in medicine; in the art of dyeing, for the preparation of colours; in metallurgy, for the indication and ſeparation of ſome metallic ſubſtances; and in the arts, for covering the ſurface of copper and other veſſels, to prevent oxydation in the proceſs of tinning; and for the ſame purpoſe in ſoldering.

6. Hyperoxymuriate of Ammonia.

1128 Preparation.

The compound of hyperoxymuriatic acid and ammonia is formed by pouring carbonate of ammonia into a ſolution of any of the earthy hyperoxymuriates. A double decompoſition takes place, and a hyperoxymuriate of ammonia is formed. This ſalt is very ſoluble in water and in alcohol.

1129 Properties.

It is decompoſed at a low temperature, and gives out a quantity of gas together with a ſmell of hyperoxymuriatic acid. Such a ſmell, Mr Chenevix obſerves, is doubtleſs owing to the great quantity of oxygen contained in the acid, which is more than what is neceſſary to combine with the hydrogen contained in the alkali. Seme part, therefore, is diſengaged without decompoſition. Mr Chenevix who formed this ſalt, could not ſucceed in aſcertaining the proportion of its conſtituent parts *.

7. Fluate of Ammonia.

1130 Preparation and properties.

1. This compound of fluoric acid and ammonia is prepared by ſaturating the acid with the alkali. By evaporation it cryſtallizes in ſmall needles or priſms, which have a pungent taſte analogous to that of ſulphate of ammonia.

2. When it is heated, this ſalt gives out ammonia, and is ſublimed in the ſtate of an acidulous fluate. This ſalt decompoſes the nitrate and muriate of lime, and the ſulphate of magneſia.

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* Nicholſon's Journal, iii. 216.

* Phil. Tranſ. 1802, p. 148.

8. Borate of Ammonia.

The compound of boracic acid and ammonia is little known. It is formed by the direct union of the acid with the alkali. It has ſo little permanency, that the ſolution being evaporated, the whole of the ammonia is volatilized, while the boracic acid cryſtallizes. The baſe of every other ſalt decompoſes it †.

9. Phoſphate of Ammonia.

1131 Names and hiſtory. 1. This ſalt, the compound of phoſphoric acid and ammonia, was long confounded with the phoſphate of ſoda, as it exiſts with it in urine, under the names of *fuſible ſalt*, *native ſalt of urine*, *microcoſmic ſalt*. It was firſt accurately diſtinguiſhed by Schloſſer, De Chaulnes, and Rouelle, about the year 1770; ſoon after by Lavoiſier, and more lately by Vauquelin.

1132 Preparation. 2. At firſt it was extracted from the ſalt of urine; and many proceſſes were adopted to obtain it pure, and ſeparate from the muriate and phoſphate of ſoda, with which it is always accompanied. It is now prepared artificially by directly combining phoſphoric acid with ammonia; and by ſlow evaporation of the ſolution to a certain conſiſtence cryſtals are obtained on cooling.

1133 Properties. 3. The phoſphate of ammonia cryſtallizes in regular four-ſided priſms, terminated by four equal-ſided pyramids, and ſometimes in the form of ſmall needles cloſely interwoven with each other. It has a cooling, ſaline, pungent taſte, and changes the ſyrup of violets to a green colour. Its ſpecific gravity is 1.8051.

1134 Action of water. 4. In a moiſt air, it is ſlightly deliqueſcent, but otherwiſe it is unchanged. It is ſoluble in four parts of cold water, and ſtill more ſo in boiling water.

1135 Of heat. 5. Expoſed to heat, it undergoes the watery fuſion, ſwells up, and melts into a tranſparent glaſs, which is acid, part of the baſe being driven off. Hence it derived the name of *fuſible ſalt*.

1136 Acids. 6. It is readily decompoſed by charcoal, by the ſulphuric, nitric, and muriatic acids, and by the two fixed alkalies.

1137 Uſes. 7. The phoſphate of ammonia is employed as a flux in eſſaying mineral ſubſtances with the blow-pipe. It is greatly uſed alſo in the fabrication of coloured glaſſes and artificial precious ſtones.

10. Phoſphite of Ammonia.

1138 Preparation. 1. This is a compound of phoſphorous acid and ammonia. It is prepared by the direct combination of the acid with ammonia or the carbonate of ammonia, and by ſlow evaporation it may be obtained in cryſtals.

1139 Properties. 2. It ſometimes cryſtallizes in long tranſparent needles, and ſometimes in four-ſided priſms, terminated by four-ſided pyramids. It has a ſtrong pungent taſte.

1140 Action of water. 3. This ſalt is ſlightly deliqueſcent in the air, is ſoluble in twice its weight of cold water, and being more ſoluble in boiling water, it cryſtallizes on cooling.

1141 Of heat. 4. When it is heated on charcoal with the blowpipe, it boils up, and loſes its water of cryſtallization. When this has eſcaped, it is ſurrounded with a fine phoſphoric light; and as the ſalt begins to vitrify, there are evolved bubbles of gas, which burn as they come in contact with the air, with a vivid flame, and form with the atmoſphere a ring of white vapour of phoſphoric acid. What remains is phoſphoric acid in the vitreous ſtate. The ſame effect may be produced by heating ſix or ſeven grains of the ſalt in a ſmall glaſs globe to which a tube is adapted, and immerſed under jars over mercury. The ſalt melts, ſwells, and gives out bubbles of phoſphorated hydrogen gas, which ſpontaneouſly inflame as they come in contact with the air, and exhibit the white coronet of vapour which is the characteriſtic property of the combuſtion of this gas. During this decompoſition, the baſe of the ſalt, the ammonia, is alſo volatilized, and pure phoſphoric acid remains behind. This ſalt is decompoſed by charcoal, the acids, and by potaſh and ſoda.

1142 Compoſition. 3. The conſtituent parts of this ſalt are the following.

Phoſphorous acid,	26
Ammonia,	51
Water,	23
	100

6. It has not hitherto been applied to any uſe.

11. Carbonate of Ammonia.

1143 Names. 1. The compound of carbonic acid with ammonia has been diſtinguiſhed by different names, as *concrete volatile alkali*, *aërated volatile alkali*, and *cretaceous ſal ammoniac*. Its peculiar nature and properties were not clearly underſtood, till, by the diſcovery of Dr Black, it was demonſtrated to be a compound ſalt. This ſalt is obtained by a great many different proceſſes. Formerly it was procured by diſtilling animal matters, and particularly horns, as the horns of the hart, whence it derived the name of volatile ſalt of hartſhorn.

1144 Preparation. 2. Carbonate of ammonia may be prepared by directly combining carbonic acid and ammonia in the ſtate of gas over mercury; or it may be obtained by mixing together two parts of chalk, and one part of muriate of ammonia, well dried and reduced to powder, and expoſing them to heat in a porcelain retort. The gas, as it comes over, is collected in a receiver, which is to be cooled with cloths moiſtened with water. This is the carbonate of ammonia, which is ſublimed and attaches itſelf to the ſides of the receiver. In this proceſs there is a double decompoſition. The carbonic acid of the lime combines with the ammonia, and forms carbonate of ammonia, which is driven off by heat; and the muriatic acid of the muriate of ammonia combines with the lime, and forms muriate of lime, which remains in the retort.

1145 Properties. 3. The carbonate of ammonia is cryſtallized; but the cryſtals are ſo irregular, that their form has not been accurately aſcertained. Bergman deſcribes them as octahedrons, whoſe four angles are truncated; while, according to Romè de Liſle, they are compreſſed four-ſided priſms, terminated by a two-ſided ſummit. The taſte of this ſalt is ſlightly acrid, and the ſmell is perceptibly that of ammonia, though more feeble. It converts vegetable blues to green. Its ſpecific gravity is 0.966.

1146 Action of water. 4. When this ſalt is pure, it is not ſenſibly changed by expoſure to the air. It is very ſoluble in water, and, during its ſolution, produces cold. Two parts of cold water diſſolve more than one of the ſalt. Water, at the temperature of about 120°, diſſolves more than

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† Fourcroy Connaiſs. Chim. iii. p. 336.

its own weight, &c. When it is rapidly cooled, the ſalt cryſtallizes in the moſt regular form which it aſſumes. Boiling water cannot be employed for its ſolution, becauſe at this temperature the ſalt is driven off in the ſtate of vapour.

1147 Of heat.

When this ſalt is thrown upon hot iron, it melts, boils, and is converted into vapour.

1148 Of acids.

5. It is decompoſed by all the acids with effervefcence; and the effervefcence with this ſalt is more violent than with the carbonate of the two fixed alkalies, becauſe the proportion of carbonic acid is greater.

1149 Compoſition.

6. The conſtituent parts of this ſalt, according to Bergman, are,

Carbonic acid	45
Ammonia	43
Water -	12
	100

But Mr Davy has found, that the proportion of acid and water in this ſalt depends on the temperature at which it is formed. It is greater when the temperature is low, and diminiſhes as the temperature is increaſed.

1150 Uſes.

7. This ſalt is employed in medicine, and alſo in the manufacture of muriate of ammonia, for which purpoſe it is produced by diſtillation from animal matters. The uſe of it, when it is mixed with volatile oils, as a perfume, or as a ſtimulant in ſmelling bottles, is well known.

12. Arſeniate of Ammonia.

1151 Preparation.

1. This ſalt, the compound of arſenic acid and ammonia, is formed by combining the acid with the alkali. When the ſolution is evaporated, it affords cryſtals of arſeniate of ammonia.

1152 Properties.

2. It cryſtallizes in the form of rhomboidal priſms; or, with an exceſs of acid, in the form of needles. The cryſtals of the firſt convert the ſyrup of violets into green, and thoſe of the ſecond are deliqueſcent in the air.

1153 Action of heat.

3. When this ſalt is gently heated, the ammonia is diſengaged, and the arſenic acid remains behind; but when the heat is violent and ſudden, part of the alkali and of the acid are decompoſed, water is formed, azotic gas is diſengaged, and the arſenic is ſublimed in the metallic ſtate.

13. Arſenite of Ammonia.

This is a compound of the white oxide of arſenic, or arſenious acid, with ammonia; but nothing is known of its properties.

14. Tungſtate of Ammonia.

1154 Preparation.

1. This compound of tungſtic acid and ammonia is formed by diſſolving the oxide of tungſten in the ſolution of ammonia or carbonate of ammonia; and by evaporating the ſolution, the ſalt is obtained in the form of cryſtals.

1155 Properties.

2. It cryſtallizes in ſmall ſcales, which have ſome reſemblance to boracic acid; or in ſmall needles, which are four-ſided. This ſalt has a metallic taſte. It is not deliqueſcent in the air, but is ſoluble in water. When it is expoſed to heat, it is decompoſed.

3. The component parts of this ſalt are,

Tungſtic acid .	18
Ammonia and water	22
	100

15. Molybdate of Ammonia.

16. Chromate of Ammonia.

17. Acetate of Ammonia.

1156 Preparation.

1. This compound of acetic acid and ammonia has been long known by the name of *ſpiritus mindereri*. In this ſtate it is combined with an exceſs of acid. It may be obtained but, with ſome difficulty, on account of its volatility, by ſlow evaporation. It then cryſtallizes in the form of needles. Cryſtals are alſo obtained by very ſlow ſublimation of this ſalt.

1157 Properties.

2. The cryſtals of acetate of ammonia are long, ſlender, flat, and pointed, of a pearly white colour *. The taſte is cooling, with a mixture of ſweet. Expoſed to air, it is deliqueſcent, and is very ſoluble in water. When it is heated to the temperature of 170°, it melts; and when the temperature is raiſed to 250°, it is ſublimed. By diſtillation of the ſalt in ſolution, with a ſtrong heat, it is partly decompoſed. The ammonia is firſt driven off, then the acid, and, towards the end of the proceſs, part of the neutral ſalt.

18. Oxalate of Ammonia.

1158 Preparation.

1. The compound of oxalic acid and ammonia may be prepared by directly combining the acid with the alkali. By evaporating the ſolution, the ſalt cryſtallizes.

2. When the acid is ſaturated with the alkali, the cryſtals are in the form of four-ſided priſms, terminated by two-ſided ſummits; one of which is larger, and includes three ſides of the priſm. Theſe ſalts are ſoluble in water.

1159 Action of heat.

3. When this ſalt is expoſed to heat, carbonate of ammonia is driven off, and nothing remains behind but a little charcoal. From this it appears, that the acid is decompoſed, the carbone and oxygen combining together to form carbonic acid, which enters into combination with ammonia. It is decompoſed by the mineral acids. The oxalic acid combines with it, and forms an acidulous oxalate of ammonia. The oxalates of potaſh and ſoda form compounds with this ſalt, which are known by the name of *triple ſalts*.

1160 Uſes.

4. This is one of the moſt uſeful ſalts to be employed as a reagent in detecting lime in liquid ſolutions, and for aſcertaining the nature and proportions of calcareous ſalts.

19. Tartrate of Ammonia.

The compound of tartaric acid and ammonia forms a ſalt which very readily cryſtallizes. This ſalt has a cooling bitter taſte, is very ſoluble in water, and eaſily decompoſed by heat. It is ſubject alſo to ſpontaneous decompoſition. By the action of the ſtronger acids part of the baſe is ſeparated, and it is converted into an acidulous tartrate of ammonia.

20. Citrate of Ammonia.

1. This ſalt, which is a compound of citric acid and ammonia, is formed by the direct combination of the

* *Higgins' Experiments*, p. 188.

acid and alkali, and it cryſtallizes when the ſolution is evaporated to the conſiſtence of a thick ſyrup.

2. The cryſtals are in the form of an elongated priſm. They are very ſoluble in water, and have a ſaline cooling taſte. This ſalt is decompoſed by heat, the ammonia being driven off.

3. It is compoſed of

Acid	62
Ammonia	38
	100

21. Malate of Ammonia.

This ſalt, which is a compound of malic acid and ammonia, is a very ſoluble and deliqueſcent ſalt. Its other properties are unknown.

22. Benzoate of Ammonia.

The compound of benzoic acid and ammonia forms a very ſoluble ſalt, which readily cryſtallizes, and the cryſtals arrange themſelves in an arboreſcent or plumoſe form. This ſalt is volatile, and is decompoſed by all other acids *.

23. Succinate of Ammonia.

The compound of ſuccinic acid and ammonia forms a ſalt, which affords needle-ſhaped cryſtals that are deliqueſcent, and are ſublimed by heat, without being decompoſed.

24. Saccolate of Ammonia.

Nothing farther is known of this ſalt, than that it has an acid taſte, and is readily decompoſed by heat.

25. Camphorate of Ammonia.

1161 Preparation. 1. This ſalt, which is a compound of camphoric acid and ammonia, is prepared by adding the acid to a ſolution of carbonate of ammonia, and hot water, till effervescence ceaſes. The evaporation muſt be conducted with a very gentle heat, on account of the volatility of the ammonia.

1162 Properties. 2. It is difficult to obtain this ſalt cryſtallized. When the ſolution is too much evaporated, it affords a cryſtalline maſs, in which appear ſmall needles; but if it be evaporated to dryneſs there remains a ſolid opaque maſs, which has a ſlightly bitter and pungent taſte.

3. This ſalt is ſlightly deliqueſcent in the air; it is not very ſoluble in cold water, but may be diſſolved in three parts of boiling water. In theſe ſalts, it would appear that the acid reſiſts the action of the water; for when there is an exceſs of baſe, they become more ſoluble.

1163 Action of heat. 4. Expoſed to heat on red-hot coals, it ſwells and melts, and then riſes in vapour. With the blow-pipe, it gives a blue and red flame, and is entirely diſſipated.

1164 Of acids. 5. This ſalt is decompoſed by the ſulphuric, nitric, and muriatic acids, and if the ſolution be ſufficiently concentrated, the camphoric acid is depoſited. It is alſo decompoſed by potaſh and ſoda, and more rapidly with the aſſiſtance of heat. This ſalt is completely ſoluble in alcohol †.

26. Suberate of Ammonia.

This compound of ſuberic acid with ammonia affords cryſtals in the form of parallelopipeds. It has a ſlight ſaltiſh taſte, leaving an impreſſion of bitterneſs. It reddens vegetable blues, and is deliqueſcent in the air. It is very ſoluble in water. When it is thrown on burning coals, it ſwells up, and is deprived of its water of cryſtallization. It is entirely diſſipated by the action of the blow-pipe. It is decompoſed by the ſulphuric, nitric, muriatic, and oxalic acids, by the fixed alkalies, and the aluminous and magneſian ſalts ‡.

27. Mellate of Ammonia.

This ſalt, which is a compound of mellitic acid and ammonia, is formed by ſaturating the acid with the alkali. By evaporation it affords tranſparent, ſix-ſided cryſtals. This ſalt when expoſed to the air, becomes opaque, and of a ſilvery white colour.

28. Lactate of Ammonia.

This compound of lactic acid and ammonia forms a ſalt which cryſtallizes. It is deliqueſcent in the air, and is decompoſed by heat, great part of the ammonia being driven off.

29. Pruſſiate of Ammonia.

The compound of pruſſic acid and ammonia affords a ſalt which has the odour of ammonia. When this ſalt is expoſed to heat, it is entirely diſſipated.

30. Sebate of Ammonia.

31. Urate of Ammonia.

The compound of uric acid and ammonia, forms a ſalt which is not very ſoluble in water, and in many of its properties reſembles the acid itſelf.

IV. Compounds of Ammonia with Inflammable Subſtances.

1. Ammonia enters into combination with alcohol, with the aſſiſtance of a moderate heat; but the ammonia is ſeparated when the mixture is expoſed to a temperature below the boiling point of alcohol.

2. Ammonia readily mixes with ether; but the nature of the compound, or whether it be a chemical combination, is not known.

3. Ammonia forms a compound with the fixed oils, which is well known under the name of *ſoap* or *liniment*.

4. With the volatile oils it forms compounds, which have ſomewhat ſimilar properties.

Caap. XIII. Of EARTHS.

1. The word *earth* is taken in different ſignifications. Sometimes it ſignifies the globe, and ſometimes it is uſed to denote the ſoil on the ſurface of the globe. In chemiſtry it is employed to ſignify certain elementary ſubſtances, of which a great proportion of the ſolid parts of the globe is compoſed; and theſe ſubſtances are found to poſſeſs many peculiar, and ſome common properties.

1165 Properties. 2. The general properties of the earths are the following.

a. They have neither taſte nor ſmell.

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* *Fourcroy Connaiſs. Chim.* vii. 193.

† *Ann. de Chim.* xxvi. p. 31.

‡ *Annal. de Chim.* tom. xxiii. p. 55.

b. They are incombuſtible.

c. They are nearly inſoluble in water.

d. They have a ſpecific gravity which is under 5.

1166 Enumeration. The number of the earths which are at preſent known, is nine, and we ſhall treat of them in the following order.

1. Lime,
2. Barytes,
3. Strontites,
4. Magneſia,
5. Alumina,
6. Silica,
7. Yttria,
8. Glucina,
9. Zirconia.

SECT. I. *Of LIME.*

1167 Early known. 1. Lime has been known from the remoteſt antiquity. The great abundance in which it is found in nature, and the important uſes to which it may be applied, led men to employ it for many purpoſes from the earlieſt ages of the world. It was well known to the ancients as mortar, and as a manure, and they were not unacquainted with ſome of its medicinal virtues. But it was long before the nature and properties of lime were fully known; and particularly thoſe changes which quicklime undergoes when it is expoſed to the air, or limeſtone to the action of heat. It was not till Dr Black made his brilliant diſcoveries, that the nature of theſe changes was fully developed, and the fanciful theories which had been propoſed to account for them were entirely rejected.

1168 Preparation of pure lime. 2. Lime is ſeldom found perfectly pure in nature; but it is univerſally diffuſed, and exiſts in ſome places in the greateſt abundance, in combination with other ſubſtances, and particularly with carbonic acid. To obtain it pure, a quantity of chalk, or marble, or limeſtone, is expoſed to a ſtrong heat, by which means the carbonic acid with which it is in combination is driven off. When the limeſtone, or marble, or chalk, which has been employed, is ſufficiently burnt or calcined, and removed from the fire, and water poured upon it, it ſwells up, and at laſt falls down into a powder. This powder is called *quicklime*. In this proceſs of ſlaking lime, as it is called, a great quantity of water is quickly abſorbed, and the water being fixed in the lime in the ſolid ſtate, gives out that caloric which is neceſſary to retain it in the ſtate of liquidity, ſo that a great quantity of heat is evolved. 1169 Slaking. Part of the water, alſo, riſes in vapour, in conſequence of the great heat, before it is conſolidated with the lime. The heat produced is ſo great, that water may be boiled, and combuſtible bodies may be inflamed. Accidents have happened to carriages and veſſels loaded with lime, to which water had been admitted. So much heat was produced, that they have been ſet fire to, and burnt. Light is alſo emitted when lime is ſlaked. This, it is ſaid, is ſeen when the proceſs is conducted in a dark place, and the quantity of lime conſiderable.

3. The purity of lime thus obtained, is in proportion to the purity of the ſubſtance which was calcined. The lime which is obtained by burning pure white marble, or what is called *calcareous ſpar*, is tolerably pure. But there are other proceſſes by which thoſe ſubſtances with which it may happen to be mixed may be ſeparated. If a quantity of chalk be waſhed in pure water, diſſolved in diſtilled acetic acid, and afterwards precipitated by carbonate of ammonia, the precipitate being waſhed and calcined, pure lime is the product. The lime which is obtained from oyſter-ſhells, may be rendered pure by the following proceſs. Firſt waſh the ſhells in different quantities of water, and boil them, to ſeparate any mucilaginous ſubſtance. Introduce them into a furnace, and calcine them to whiteneſs. After the firſt calcination, put them into a porcelain retort, and expoſe it to a red heat. By this proceſs pure lime is obtained. To preſerve it in this ſtate of purity, it muſt be kept in cloſe veſſels.

1170 Properties. 4. Pure lime is of a white colour, has a hot, ſharp, cauſtic taſte, and deſtroys the texture of animal ſubſtances, to which it is for ſome time applied. It converts the ſyrup of violets and other vegetable blues to a green colour. The ſpecific gravity of lime is 2.3.

1171 Action of water. 5. After the lime has been thus prepared and ſlaked; if more water be added to dilute it, and reduce it to the conſiſtence of thick cream, this is what was formerly called *milk*, or *cream of lime*. But if a greater quantity of water be added, and the ſolution be filtered, a tranſparent liquid is thus obtained, which is known by the name of lime water. Four hundred and fifty parts of water are required, it is ſaid, to diſſolve one of lime. This water is clear and limpid, has a ſharp, acrid taſte, and renders the ſyrup of violets green. When this water is evaporated, and the whole driven off, the lime remains pure. If the ſolution of lime-water be expoſed to the air, the ſurface is ſoon covered with a pellicle, which gradually acquires ſolidity and thickneſs. This pellicle is owing to the attraction of the lime for the carbonic acid of the atmoſphere, forming a carbonate of lime, which being inſoluble in water, is precipitated.

1172 Cryſtallizes. 6. Lime, according to Trommſdorf, cryſtallizes. This was firſt diſcovered by Scheele. The method by which Mr Trommſdorf obtained the cryſtals of lime is the following. Boil any quantity at pleaſure of muriate of lime, with one-fourth or leſs of cauſtic lime, and evaporate the ſolution till a drop of it let fall on a cold ſtone aſſume the conſiſtence of ſyrup. It is then to be filtered, and put into a cloſe veſſel, that the ſolution may cool as ſlowly as poſſible. Cryſtals of lime are thus obtained, which muſt be waſhed in alcohol, to ſeparate any part of the muriate of lime which may adhere. For the complete ſucceſs of this experiment, ſome pounds of the muriate of lime muſt be employed *.

1173 Action of heat. 7. Lime undergoes no change by the action of light, and it remains unaltered when it is expoſed to the greateſt heat.

8. Lime is one of the moſt important of the earthy bodies. It is applied to a great many valuable purpoſes, and fortunately it can be obtained in the greateſt abundance. It is employed in medicine, both as an internal remedy, and an external application. As a manure, it is of the moſt extenſive utility; nor is it of leſs importance, as it is employed for a cement in building. When quicklime is mixed with ſand and water, and reduced to the form of a thick paſte, it is in the

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* Phil. Mag. xii. 53.

ſtate of mortar. It is an object of the utmoſt importance that the mortar which is employed as a cement in building, ſhould be durable. To attain this object, a good deal of attention has been paid by different philoſophers in aſcertaining the proportions which ſeem to anſwer beſt, or the additions which may be made to the uſual materials in the formation of good and durable mortar. 1174 Mortar. The proportions which have been propoſed by Dr Higgins are,

Coarſe ſand,	4 parts,
Fine ſand,	3
Quicklime,	1

The lime ſhould be recently ſlaked, and the quantity of water ſhould be juſt ſufficient to bring it to a proper conſiſtency.

Dr Higgins found that burnt bones, if they did not exceed one-fourth of the lime, added to the mortar, improved its tenacity, and prevented it from cracking in drying.

It has been propoſed to add a certain proportion of unſlaked lime to the mortar, with the view of giving it greater ſolidity. Mortar acquires its hardneſs from the lime abſorbing carbonic acid, and returning to the ſtate of limeſtone, and alſo from the combination of part of the water with the lime. According to Guyton's experiments the following proportions compoſe a good, durable mortar.

Fine ſand	3 parts,
Cement of well-baked bricks	3
Slaked lime	2
Unſlaked	2

It is ſometimes neceſſary to uſe mortar as a cement under water, but common mortar is unfit for this purpoſe. It has been found by experiment, that manganeſe added to mortar, gives it the property of conſolidating under water. To prepare a mortar for this purpoſe, Guyton recommends the following proceſs. Mix together 90 parts of limeſtone, ſix parts of black oxide of manganeſe, and 4 parts of blue clay in the ſtate of powder. Let the mixture be calcined, to drive off the carbonic acid; then add 60 parts of ſand, and mix it together with a ſufficient quantity of water, to bring it to the conſiſtency of mortar.

1175 Affinities. 9. The order of the affinities of lime is the following:

Oxalic acid,
Sulphuric,
Tartaric,
Succinic,
Phoſphoric,
Saclactic,
Nitric,
Muriatic,
Suberic,
Fluoric,
Arſenic,
Lactic,
Citric,
Benzoic,
Sulphurous,
Acetic,
Boracic,
Carbonic,
Pruſſic.

I. Phoſphuret of Lime.

1176 Preparation. 1. Lime combines with phoſphorus, and forms a compound which is called *phoſphuret of lime*. To prepare this compound, introduce into the bottom of a glaſs tube, cloſed at one end, one part of phoſphorus, and afterwards place a little above it four or five times its weight of quicklime in powder. Expoſe to a heat that part of the tube which contains the lime, ſo that it may become red hot. In this ſtate raiſe the tube and draw it along the coals, till that part of it containing the phoſphorus be alſo expoſed to the heat. The phoſphorus is raiſed in the ſtate of vapour through the lime, and combines with it, ſo that the whole maſs forms a compound of a brown colour. This is the phoſphuret of lime.

1177 Properties. 2. It has a deep brown colour, no ſmell, and when it is expoſed to the air it falls to pieces. It is inſoluble in water, but it decompoſes that liquid at the moment it comes in contact with it. An efferveſcence takes place, and phoſphorated hydrogen gas is emitted, which is ſpontaneouſly inflamed when it comes to the ſurface of the water. It is owing to this gas that phoſphuret of lime, when it is moiſtened, gives out the fetid ſmell of garlic; and as this gas is formed by the decompoſition of the water, part of it combines with the phoſphuret of lime and forms a hydrogenated phoſphuret, ſo that the phoſphuret when it is taken from the water and dried, gives out flame, when concentrated muriatic acid, which diſengages the phoſphorated hydrogen gas, is poured upon it.

II. Sulphuret of Lime.

1178 Preparation. 1. This compound of ſulphur and lime may be formed by expoſing to heat in a crucible, ſulphur and lime reduced to powder. They fuſe ſlightly, or rather combine into an acrid, reddiſh maſs, which is the ſulphuret of lime, formerly called *calcareous liver of ſulphur*.

1179 Hydrogenated ſulphuret. 2. When it attracts moiſture from the air, or if a little water be thrown upon it, it changes colour, and paſſes to a greeniſh yellow, emitting at the ſame time an extremely fetid odour, and forming ſulphurated hydrogen gas, becomes a hydrogenated ſulphuret.

3. When ſulphur and lime are combined together by means of water, the reſult is not a ſimple ſulphuret, but always a hydrogenated ſulphuret, on account of the water which is decompoſed. This may be prepared, either by throwing water on quicklime, covered with ſulphur in powder; the heat which is emitted by the ſlaking of the lime effecting the combination: or it may be prepared by heating in a matraſs, ſulphur and lime in powder with 10 times their weight of water, or by heating lime water on ſulphur. By the two firſt proceſſes, a liquid is obtained of a red, orange, or yellow colour, of an extremely fetid odour, and a pungent, acrid taſte. This hydrogenated ſulphuret of lime expoſed to the air, is deprived of its colour, gradually decompoſed, and the ſulphur combining with the oxygen of the air, is firſt converted into ſulphurous, and afterwards into ſulphuric acid. It is decompoſed

by the acids, ſulphur is precipitated, and ſulphurated hydrogen gas is diſengaged.

1180 Hydro-ſulphuret. 4. Lime combines readily with ſulphurated hydrogen. When ſulphurated hydrogen gas is paſſed into a bottle of lime-water, the gas is abſorbed and fixed by combining with the lime, it renders it more ſoluble, and forms the hydroſulphuret of lime. This hydroſulphuret, as Berthollet obſerves, performs the part of an acid, by ſaturating the lime, and gives it the property of cryſtallizing. This hydroſulphuret has no colour, and, expoſed to the air, emits a ſtrong fetid odour. It is extremely ſoluble in water, and is decompoſed by the acids with effervеſcence, while ſulphurated hydrogen gas is given out. Thus, lime enters into three different combinations with ſulphur, namely into the ſulphuret of lime, the hydroſulphuret, and the hydrogenated ſulphuret.

III. Compounds of Lime with Acids.

1. Sulphate of Lime.

1181 Names. 1. The compound of ſulphuric acid and lime has been known under a great variety of names, as *ſelenite*, *gypſum*, *plaſter of Paris*, *alabaſter*, *vitriol of lime*. The ſulphate of lime is found in great abundance in nature; and it is found ſufficiently pure, ſo that artificial preparation is not required.

1182 Found native.

1183 Properties. 2. When ſulphate of lime is pure, it is frequently found cryſtallized. The primitive form of its cryſtals is a quadrangular priſm, whoſe baſes are rhomboidal, and the angles 113° and 67°. The integrant particle has the ſame form. The ſpecific gravity is from 2.1679 to 2.3114. It is not changed by expoſure to the air. It is little ſoluble in water. Five hundred parts of cold water, and 450 of boiling water, are required to diſſolve it. When it is expoſed to heat, it loſes its water of cryſtallization, decrepitates, becomes very friable, and falls down into a very white opaque powder. When this powder is reduced to a paſte with water, it abſorbs it very rapidly, and becomes in a very ſhort time ſolid. From this peculiar property, it is employed for forming *caſts*, under the name of plaſter of Paris. When it is ſtrongly heated for a long time, it becomes phoſphoreſcent, and then melts; and before the blowpipe it gives an opaque, vitreous globule.

1184 Action of heat.

1185 Of acids. 3. This ſalt becomes more ſoluble by the action of ſulphuric acid, without being converted into an acidulous ſulphate of lime. The nitric and muriatic acids increaſe its ſolubility without decompoſing it. It is partly decompoſed by the phoſphoric acid in the cold.

1186 Compoſition. 4. The component parts of ſulphate of lime, according to Bergman, are,

Acid	46
Lime	32
Water	22
	100

After being dried in different temperatures, according to Mr Kirwan, the component parts are,

	Dried in 270°	In a red heat.	In a white heat.
Acid	50.39	55.84	59
Lime	35.23	38.81	41
Water	14.38	5.35	00
	100.00	100.00	100

Anhydrous Sulphate of Lime.

This is a variety of the ſulphate of lime found native in different places, which, as the name imports, contains no water of cryſtallization. It is found cryſtallized. The primitive form of the cryſtal is a rectangular priſm, having two of its baſes broader than the other two. The ſpecific gravity is 2.950. It has a pearly luſtre, conſiderable hardneſs, phoſphoreſces when it is heated, is tranſparent, and inſoluble in water. The component parts are, according to the analyſis of Mr Chenevix,

Acid	44.88
Lime	55.12
	100.00

2. Sulphite of Lime.

1187 Preparation. 1. This ſalt may be prepared by paſſing a current of ſulphurous acid gas into a bottle of diſtilled water, in which is ſuſpended pure carbonate of lime in powder. A briſk effervеſcence takes place; the ſulphite, as it forms, falls to the bottom in the ſtate of powder; and if the gas be continued to be added after the effervеſcence has ceaſed, the ſulphite of lime in the ſtate of powder is completely re-diſſolved; the liquid becomes warm; and as it cools, it affords cryſtals.

1188 Properties. 2. This ſalt is either in the ſtate of white powder, or in the form of ſix-ſided priſms, terminated by long, ſix-ſided pyramids. At firſt it has no taſte, but when it is kept in the mouth for ſome time, it becomes ſulphureous. It effloreſces ſlowly when expoſed to the air, and is converted into ſulphate of lime on the ſurface. It is leſs ſoluble in water than the ſulphate of lime, requiring 800 parts of water to diſſolve it.

1189 Action of heat. 3. When it is expoſed to heat, it is deprived of ſome water, becomes white, and is reduced to powder. A ſtrong heat ſeparates ſome ſulphur, and it is then converted into ſulphate of lime.

1190 Compoſition. 4. The component parts of this ſalt are,

Sulphurous acid	48
Lime	47
Water	5
	100

3. Nitrate of Lime.

1191 Hiſtory. 1. This ſalt, which is the compound of nitric acid and lime, has been long known under the names of *calcareous nitre*, *mother water of nitre*, Baldwin's phoſphorus. It always accompanies nitre, and, as one of its names imports, remains in the ſolution from which nitre has been obtained.

1192 Preparation. 2. This ſalt may be prepared by diſſolving carbonate of lime in nitric acid, evaporating to the conſiſtence of ſyrup, and allowing the ſolution to cool ſlowly. It is thus obtained in the ſtate of cryſtals.

1193 Properties. 3. The cryſtals of nitrate of lime are in the form of ſix-ſided priſms, terminated by long pyramids. Sometimes they are in the form of long ſtriated needles, grouped together, of a ſilvery whiteneſs. The taſte is acrid, hot, and bitter. The ſpecific gravity is 1.6207.

1194 Action of water. 4. This is one of the moſt deliqueſcent ſalts. Expoſed to the air for a few hours, it is totally melted.

It is ſometimes employed in chemiſtry on account of this property of attracting moiſture, to deprive gaſes of the vapour of water with which they may be combined. For this purpoſe, the gaſes are made to paſs through tubes which contain dried nitrate of lime. It is owing to a mixture of this ſalt, that nitre is ſometimes deliqueſcent in the air. The nitrate of lime is extremely ſoluble in water. One part of cold water diſſolves four of this ſalt. Boiling water diſſolves ſtill more.

1195 Of heat. 5. When heated, this ſalt is very fuſible. It melts like oil, and after it becomes dry, it often acquires, during calcination, the property of becoming luminous in the dark. Hence the origin of one of its names. More ſtrongly heated, it is decompoſed; gives out red vapours of nitrous gas, oxygen and azotic gaſes, and there remains behind pure lime.

1196 Of acids. 6. This ſalt is decompoſed by the ſulphuric acid, partially by the phoſphoric, and by potaſh and ſoda. By double affinity it is decompoſed by the ſulphates of potaſh, of ſoda, and ammonia. Sulphate of lime, which is an inſoluble ſalt, is always precipitated.

1197 Compoſition. 7. By the analyſis of Bergman, the conſtituent parts of nitrate of lime are the following.

Acid,	43
Lime,	32
Water,	25
	100

By the analyſis of Mr Kirwan, when it is well dried in the air,

Acid,	57.44
Lime,	32.00
Water,	10.56
	100.00

This ſalt has not been applied to any uſe. It is recommended by Fourcroy as a ſubſtitute for nitre in the extraction of nitric acid *.

4. Nitrite of Lime.

When the nitrate of lime is expoſed to heat, till it give out ſome bubbles of oxygen gas, there remains behind a calcareous nitrite, which converts vegetable blues to green, and gives out a great quantity of red vapour by the action of acids. It ſeems to be in the ſtate of nitrite of lime, that this compound poſſeſſes the phoſphoreſcent property †.

5. Muriate of Lime.

1198 Names. 1. The compound of muriatic acid and lime has been known by the names of *calcareous marine ſalt*, *fixed ſal ammoniac*, and *Homberg's phoſphorus*. This ſalt is frequently found in ſolution in ſome mineral waters.

1199 Preparation. 2. It is prepared by ſaturating muriatic acid with carbonate of lime, and evaporating the ſolution to the conſiſtence of ſyrup. It cryſtallizes on cooling.

1200 Properties. 3. The muriate of lime cryſtallizes in ſix-ſided priſms, terminated by ſix-ſided pyramids. The taſte is acrid, bitter, and diſagreeable. It is extremely deliqueſcent in the air. Cold water diſſolves nearly double its weight. Its ſpecific gravity is 1.76.

1201 Action of heat. 4. Expoſed to heat, it becomes ſoft, melts, and ſwells up, and then is deprived of its water of cryſtallization. At a very high temperature it is alſo deprived of part of its acid. In this ſtate, with an exceſs of lime, it acquires the property of ſhining in the dark, from which it has been called *the phoſphorus of Homberg*.

1202 Of Acids. 5. This ſalt is decompoſed by the ſulphuric acid, by the nitric acid, which converts it into the oxymuriatic, and partly by the phoſphoric and fluoric acids.

1203 Compoſition. 6. According to the analyſis of Bergman, the conſtituent parts of this ſalt are,

Muriatic acid,	31
Lime,	44
Water,	25
	100

But according to Mr Kirwan, when it is dried in a red heat, it is compoſed of

Acid,	42
Lime,	50
Water,	8
	100

1204 Uſes. 7. This ſalt is only employed for chemical experiments, and particularly for the production of artificial cold, by mixing it with ſnow or pounded ice. Of all the ſalts employed for this purpoſe, it ſeems to have the greateſt effect, in conſequence of the rapid tranſition from the ſolid to the liquid ſtate. To prepare the ſalt for this purpoſe, it is moſt convenient to evaporate it to the conſiſtence of a pretty thick ſyrup; and then by ſtirring it conſtantly as it cools, it is obtained in a dry granulated ſtate, which ſhould be reduced to powder in cold, and put up in bottles ſecured with ground ſtoppers.

6. Hyperoxymuriate of Lime.

1205 Preparation. This ſalt, which is the compound of hyperoxymuriatic acid and lime, is prepared by putting a quantity of pure white marble, reduced to powder, into one of the bottles of Woulfe's apparatus, half filled with water, and by paſſing a current of oxymuriatic acid gas into the liquid, till the efferveſcence ceaſes, and the powder has nearly diſappeared. It acquires a pungent ſtyptic taſte, with a reddiſh colour. It exhales the odour of oxymuriatic acid, and not of the hyperoxymuriatic acid. When ammonia is added to this ſolution, it is decompoſed, and there remains ordinary muriate of lime, from which circumſtance it ſeems doubtful whether there is at all formed a hyperoxymuriate of lime. According to Mr Chenevix, this ſalt is extremely deliqueſcent, melts at a low heat, in its water of cryſtallization, and is very ſoluble in alcohol.

1206 Compoſition. The component parts of this ſalt are,

Acid,	55.2
Lime,	28.3
Water,	16.5
	100.0 *

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* *Fourcroy Connaiſs. Chim* iii. p. 133.

† *Ibid.* p. 159.

* *Phil. Tranſ.* 1802. p. 147.

1207 Uſes. This ſalt has been ſucceſsfully employed in the proceſs of bleaching.

7. Fluate of Lime.

1208 Hiſtory. 1. The compound of fluoric acid and lime has been long known under the names of *fluor ſpar*, *cubic ſpar*, and *phoſphoric ſpar*, from the figure of its cryſtals, or from ſome of its properties. This ſalt exiſts in great abundance in nature, and in a ſtate of conſiderable purity.

1209 Preparation. 2. It may be artificially prepared, by combining fluoric acid with lime in ſolution in water. The ſalt is depoſited in the form of powder in the bottom of the veſſel; and when it is taken out, it is to be well waſhed and dried.

1210 Properties. 3. When the fluate of lime is found native, it is generally cryſtallized in the form of cubes, the angles of which, and ſometimes the edges, are truncated. The primitive form of the cryſtal is the regular octahedron. The form of its integrant particle is the regular tetrahedron. It has frequently a conſiderable degree of tranſparency, and exhibits a great variety of colours. The ſpecific gravity is 3.15. It has no taſte, is not altered by expoſure to the air, and it is inſoluble in water.

1211 Action of heat. 4. When it is expoſed to heat, it decrepitates and becomes luminous in the dark; but when it has once given out this light, it cannot be reſtored, either by expoſing it to the ſun's rays, or by calcination with charcoal or any other combuſtible ſubſtance. From this circumſtance it appears, that this phoſphoreſcent property is owing to ſome volatile principle which has been a conſtituent part of the ſalt. The artificial fluate of lime alſo poſſeſſes the ſame property, and even, according to Scheele, in a higher degree. When it is ſtrongly heated, it melts into a tranſparent glaſs.

1212 Of acids. 5. This ſalt is decompoſed by the ſulphuric, nitric and muriatic acids, by the carbonates of potaſh and ſoda, and by moſt of the phoſphates. It is by decompoſing it by means of the ſulphuric acid, that the fluoric acid is obtained.

1213 Uſes. 6. The fluate of lime is much employed in ſmall pieces of ſculpture, and for ornamental purpoſes in the formation of cups, vaſes, and pyramids. It is employed alſo as a flux for mineral ſubſtances.

8. Borate of Lime.

This ſalt, which is a compound of boracic acid and lime, is prepared by pouring a ſolution of boracic acid into lime water, or by decompoſing the ſoluble alkaline borates by means of lime water. A precipitate is thus formed, of a ſalt nearly inſoluble, which is inſipid, and in the form of a white powder. Little is known of the properties of this ſalt.

9. Phoſphate of Lime.

1214 Hiſtory and preparation. 1. The compound of phoſphoric acid and lime, known under the name of *calcareous phoſphoric ſalt*, is one of the moſt intereſting diſcoveries of modern chemiſtry. This was made by Scheele and Gahn in 1774, when they proved that it formed the baſis of bones. To obtain this ſalt in a ſtate of purity, a quantity of bones is calcined to whiteneſs, reduced to powder, and well waſhed with water to ſeparate the carbonate of ſoda and other ſoluble ſalts which are generally combined with it. The phoſphate of lime is thus procured in the form of an inſipid white powder. In this ſtate it is generally mixed with a little carbonate of lime, which may be ſeparated by diluted acetic acid, and afterwards waſhing it with water.

1215 Properties. 2. By this proceſs the phoſphate of lime is procured in a ſtate of purity from the ſolid matter of bones. It has no taſte, and does not change the colour of vegetable blues. When it is prepared artificially, it is in the form of white powder, but as it exiſts in nature, it is found regularly cryſtallized. This is known to mineralogiſts under the name of *apatite*, of which there are ſeveral varieties. The primitive form of its cryſtal is the regular ſix-ſided priſm; the primitive form of the integrant molecule is a three-ſided priſm, whoſe baſes are equilateral triangles. It remains unaltered by expoſure to the air, and it is ſoluble in water.

1216 Action of heat. 3. When this ſalt is expoſed to heat, it ſcarcely undergoes any change; but when it is expoſed to the ſtrong heat of a glaſshouſe furnace, it is converted into a ſemitranſparent porcelain.

1217 Of acids. 4. The phoſphate of lime is decompoſed by the ſulphuric, nitric, muriatic, and other acids; but this decompoſition is only partial. Part of the lime only is abſtracted, and the ſalt is converted into an acidulous phoſphate of lime.

1218 Compoſition. 5. The component parts of phoſphate of lime, according to Fourcroy and Vauquelin, are,

Acid,	41
Lime,	59
	100

1219 Uſes. 6. The phoſphate of lime is of great importance in chemiſtry, for the purpoſe of extracting phoſphoric acid, to be decompoſed to obtain phoſphorus. It is alſo employed for making cupels, for poliſhing metals and precious ſtones, and for removing ſpots of greaſe from linen, paper, and ſilk. It is uſed in medicine as a remedy for rickets, to correct the ſuppoſed effects of acids in ſoftening the bones.

Superphoſphate of Lime.

1220 Hiſtory. 1. This ſalt, with an exceſs of acid, was diſcovered by Fourcroy and Vauquelin in 1795. Scheele had remarked, that the phoſphate of lime was diſſolved by an acid in human urine; but he had not aſcertained that this combination between the phoſphoric acid and the phoſphate of lime conſtituted a permanent ſalt.

1221 Preparation. 2. It may be obtained artificially by the partial decompoſition of the phoſphate of lime by means of any acid, or by diſſolving this ſalt in phoſphoric acid. This laſt proceſs, Fourcroy obſerves, is the moſt certain; and when the phoſphoric acid has diſſolved as much as it can take up of the phoſphate of lime, the ſalt is in the ſtate of acidulous phoſphate, or ſuperphoſphate.

1222 Properties. 2. This ſalt cryſtallizes in ſmall ſilky threads, or in brilliant plates of a pearly luſtre, which are attached to each other, and ſeem to have the conſiſtence of honey or glue. It has a ſtrong acid taſte. Expoſed to the air, it is ſlightly deliqueſcent. It is ſoluble in water, and the ſolution produces cold. It is more ſoluble in boiling water, and cryſtallizes by cooling.

1223 Action of heat. 4. When this ſalt is expoſed to heat, it firſt melts, and then ſwells up and dries. If the temperature be increaſed, it undergoes the igneous fuſion, and is converted into a tranſparent glaſs. The phoſphoric acid in this ſalt is more readily decompoſed by charcoal than in the neutral phoſphate of lime. It is not decompoſed by any of the acids, excepting the oxalic. The proportions of its conſtituent parts are the following.

1224 Compoſition.

Acid,	54
Lime,	46
	100 *.

10. Phoſphite of Lime.

1225 Preparation.

1. This ſalt, compoſed of phoſphorous acid and lime, is formed by the direct combination of the acid with the earth, and when they are ſaturated, it falls to the bottom in the form of white powder. This powder is re-diſſolved with an exceſs of acid, and in this ſtate of acidulous phoſphite of lime, cryſtallizes by evaporating the ſolution.

1226 Properties.

2. When thus obtained, it is in the form of a white powder, if it is juſt neutralized; but with an exceſs of acid, it forms ſmall priſms or needles. This ſalt has no taſte; it is not changed by expoſure to the air; and it is inſoluble in water.

1227 Action of heat.

3. When it is expoſed to heat, it gives out a phoſphoric light, yields a ſmall quantity of phoſphorus, and is converted into a phoſphate. By the action of the blow-pipe it melts into a tranſparent globule.

1228 Of acids.

4. The neutral phoſphite of lime is ſoluble in acids, without being decompoſed. The proportions of its conſtituent parts are,

1229 Compoſition.

Phoſphorous acid,	34
Lime,	51
Water,	15
	100

11. Carbonate of Lime.

1230 Names.

1231 Preparation.

1. This ſalt exiſts in great abundance in nature; and it is known by great variety of names, as *limeſtone*, *marble*, *chalk*. It may be prepared artificially, by directly combining carbonic acid with lime; but in this proceſs the proportions of the acid and earth muſt be accurately adjuſted; for, if there is too little acid, the firſt precipitate which is formed is re-diſſolved in the water, and ſeems to form carbonate with exceſs of lime. If there be too much acid, the carbonate firſt precipitated is alſo re-diſſolved, and diſappears in this exceſs of carbonic acid.

1232 Properties.

2. The carbonate of lime is perfectly taſteleſs. The ſpecific gravity is 2.7. It is frequently found cryſtallized, and exhibits a great variety of forms. When it is tranſparent and in the rhomboidal form, it has the property of double refraction. The primitive form of its cryſtals is an obtuſe rhomboid, whoſe angles are about 101½° and 78½°. The integrant molecule has the ſame form.

3. When it is expoſed to the air it undergoes no change. It is inſoluble in water.

1233 Action of heat.

4. Expoſed to a ſtrong heat, it decrepitates, and is deprived of its water of cryſtallization. It becomes white, opaque, and friable. If the heat be increaſed and continued, the whole of the carbonic acid is driven off in the ſtate of gas.

1234 Of acids.

5. The carbonate of lime is readily decompoſed by all the acids with efferveſcence, owing to the diſengagement of the carbonic acid in the ſtate of gas.

1235 Compoſition.

6. The component parts of carbonate of lime, as they have been aſcertained by the analyſes of Bergman and Kirwan, are the following.

	Bergman.	Kirwan.
Acid,	34	45
Lime,	55	55
Water,	11	00
	100	100

12. Arſeniate of Lime.

1236 Preparation.

This ſalt, which is a compound of arſenic acid and lime, is prepared by dropping the acid into lime water. A precipitate is formed, which is ſoluble, either with an exceſs of the baſe, or the acid. Or it may be formed by diſſolving carbonate of lime in arſenic acid. The acidulous arſeniate of lime, when it is evaporated, affords ſmall cryſtals.

1237 Action of heat.

When this ſalt is heated, it melts, but is not decompoſed *.

13. Tungſtate of Lime.

1238 Found native.

The compound formed by tungſtic acid and lime, is found native. It is from the mineral called tungſten, that the metallic ſubſtance is obtained which bears this name.

1239 Preparation.

When the ſolution of tungſtic acid is added to lime water, a precipitate of tungſtate of lime is formed, ſimilar to the native compound tungſten. This mineral is found cryſtallized. The primitive form of the cryſtal is the octahedron, which is compoſed of two four-ſided pyramids, applied baſe to baſe. It is of a yellowiſh colour, with ſome degree of tranſparency and conſiderable hardneſs. It is inſoluble in water, and is ſcarcely altered by the action of heat.

1240 Compoſition.

The ſpecific gravity is about ſix. The component parts of this ſalt are,

Tungſtic acid	70
Lime	30
	100

14. Molybdate of Lime.

15. Acetate of Lime.

1241 Preparation.

1. The compound of acetic acid and lime is formed by diſſolving the carbonate of lime in the acid, till it is ſaturated. By evaporating the ſolution till a pellicle forms on the ſurface, it cryſtallizes on cooling.

1242 Properties.

2. The cryſtals of acetate of lime are in the form of ſmall priſms, with a ſhining ſilky luſtre. The taſte is bitter and ſour. It is not changed by expoſure to the air, but is ſoluble in water. The ſpecific gravity is 1.005.

1243 Action of heat.

3. When it is expoſed to heat, it is decompoſed, partly by the ſeparation of the acid, and partly by its decompoſition.

1244 Compoſition.

The component parts of this ſalt, according to Dr Higgins, are,

Acetic acid and water	64.3
Lime	35.7
	100.0 †.

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* Fourcroy Connaiſ. Chim. iii. p. 247.

* Fourcroy, Connaiſ. Chim. v. p. 83.

† Experiments, p. 47.

16. Oxalate of Lime.

The oxalic acid ſaturated with lime, forms an inſoluble ſalt, which may be formed by dropping oxalic acid into any of the acid ſolutions of lime. The oxalate of lime thus formed, is a white powder, which converts the ſyrup of violets to a green. This ſalt cannot be decompoſed by any other acid, the affinity of oxalic acid for lime is ſo ſtrong. It is on this account that oxalic acid is employed as a teſt for lime, whether it is in a ſtate of combination, or uncombined. This ſalt may be decompoſed by expoſing it to heat. The acid itſelf is driven off, and undergoes decompoſition.

The component parts of this ſalt, according to Bergman, are,

Acid	48
Lime	46
Water	6
	100

17. Tartrate of Lime.

1245 Preparation.

The compound of tartaric acid and lime may be formed, by diſſolving lime in the acid; or by adding a ſolution of lime in powder to a ſolution of tartar in boiling water, till it ceaſes to effervеſce, and to redden vegetable blues. The ſalt precipitates in the form of a white powder, which is inſoluble, excepting with an exceſs of acid. This ſalt is decompoſed by the ſulphuric, nitric, and muriatic acids.

18. Citrate of Lime.

1246 Preparation.

This ſalt, which is a compound of citric acid and lime, may be formed by the direct combination of the acid and the earth. Small cryſtals are formed, which are precipitated, and are ſcarcely ſoluble in water, excepting with an exceſs of acid, and from this ſolution it may be obtained cryſtallized. The component parts of this ſalt are,

1247 Compoſition.

Citric acid	62.66
Lime	37.34
	100.00 *.

19. Malate of Lime.

1248 Preparation.

1. The compound of malic acid and lime may be formed by combining the acid with the earth, and neutralizing them. Small irregular cryſtals are thus obtained, which are ſcarcely ſoluble in boiling water, but become very ſoluble with an exceſs of acid. In this ſtate it is the ſupermalate of lime. This ſalt is found ready formed in ſome vegetables, as in houſe-leek and ſimilar ſucculent plants.

1249 Exiſts in plants.

1250 Properties.

2. This acidulous malate of lime has an acid taſte. When it is evaporated, it forms a ſolid, ſhining ſubſtance, analogous to varniſh. It is decompoſed by the ſulphuric and oxalic acids, and alſo by the alkalies. Lime water added to a ſolution of this ſalt, combines with exceſs of acid, and precipitates the malate of lime.

20. Gallate of Lime.

The gallic acid combined with lime, forms a yellowiſh coloured, inſoluble ſalt, which, with an exceſs of baſe, becomes ſoluble.

21. Benzoate of Lime.

The compound of benzoic acid and lime, forms a ſalt which is very ſoluble in water. This ſalt cryſtallizes in an arboreſcent form on the ſides of the veſſel which contains the ſolution. It is decompoſed by the ſulphuric, nitric, and muriatic acids. It exiſts in great abundance in the urine of graminivorous quadrupeds.

22. Succinate of Lime.

The compound of ſuccinic acid and lime forms ſalts which are not very ſoluble in water, and are not altered by expoſure to the air.

23. Saccolate of Lime.

Saclactic acid and lime form an inſoluble ſalt.

24. Camphorate of Lime.

1251 Preparation.

1. This ſalt, which is a compound of camphoric acid and lime, is formed by adding lime water to cryſtallized camphoric acid. The ſolution is then to be boiled, filtered, and evaporated to three-fourths of its quantity. As it cools, the ſalt is depoſited.

1252 Properties.

2. The camphorate of lime has no regular ſhape, unleſs the evaporation has been properly managed, when it is found in the form of plates lying on each other. It is of a white colour, and has a ſlightly bitter taſte.

1253 Action of water and heat.

3. It effloreſces in the air, and falls down into powder. It is ſcarcely ſoluble in cold, and requires about 200 parts of boiling water for its ſolution. When it is expoſed to heat, if it be moderate, it melts and ſwells, but if thrown on red-hot coals, or heated in cloſe veſſels, the acid is decompoſed and ſublimed, and the lime remains pure.

4. It is decompoſed by the ſulphuric, nitric, and muriatic acids. With the ſulphuric acid there is formed an inſoluble precipitate. The nitric and muriatic acids precipitate the camphoric acid. This ſalt is alſo decompoſed by the carbonate of potaſh, and the phoſphate of ſoda.

5. The component parts of this ſalt are,

Camphoric acid	50
Lime	43
Water	7
	100 *.

25. Suberate of Lime.

1254 Properties.

This ſalt, which is a compound of ſuberic acid and lime, does not cryſtallize, is perfectly white, has a ſlight ſaline taſte, and does not redden the tincture of turnſole. It is ſcarcely ſoluble in cold water. Boiling water diſſolves it more abundantly, but as it cools, a part of it is precipitated. When it is placed upon burning coals, it ſwells up, the acid is decompoſed, and the lime remains in the ſtate of powder. This ſalt is decompoſed by the ſulphuric, nitric, and muriatic acids, by potaſh and ſoda, and their carbonates, and by the phoſphate and borate of ſoda †.

1255 Action of heat.

26. Mellate of Lime.

The mellitic acid dropt into lime-water, forms a precipitate which is re-diſſolved by adding nitric acid.

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* *Fourcroy* vii. p. 207.

* *Ann. de Chim.* xxvii. 23.

† *Ibid.* xxiii. p. 54.

Or when the mellitic acid is mixed with a ſolution of ſulphate of lime, a precipitate is formed of ſmall, gritty cryſtals, which do not affect the tranſparency of the water.

27. Lactate of Lime.

The compound of lactic acid and lime forms a deliqueſcent ſalt, which is ſoluble in alcohol.

28. Pruſſiate of Lime.

The compound of pruſſic acid and lime is formed by diſſolving the lime in the acid. The ſolution is then to be filtered, and the lime which has not combined with the acid is to be ſeparated by adding carbonic acid in water, in the proportion neceſſary to precipitate the lime from the ſame bulk of lime-water. The ſolution, after a ſecond filtration, muſt be preſerved in cloſe veſſels. By diſtillation the pruſſic acid is driven off, and the pure lime remains behind. This ſalt is decompoſed by all the other acids, and alſo by the alkalies.

29. Sebate of Lime.

When ſebacic acid is dropped into lime-water, the tranſparency of the water is not diſturbed, ſo that the compound of this acid with lime is ſoluble in water.

IV. Compounds of Lime with Inflammable Subſtances.

Lime does not enter into combination with alcohol or ether; but it forms compounds with the fixed oils which are known by the name of ſoaps. Lime combines alſo in ſmall quantity with the volatile oils, forming a ſimilar compound.

Sect. II. *Of Barytes and its Combinations.*

1256 Hiſtory. 1. For the knowledge of this earth we are indebted to modern chemiſtry. It was diſcovered by Scheele in 1774; and its properties were inveſtigated by him, and in the following year by Gahn, who analyzed a mineral which had been diſtinguiſhed by the name of *ponderous ſpar*, on account of its weight, and found that it was compoſed of ſulphuric acid and the new earth. It received the name of *terra ponderoſa* from Bergman, who alſo examined its properties, and confirmed the experiments of Scheele and Gahn. Mr Kirwan gave it the name of *barytes*, from the Greek word βαρυς, which ſignifies heavy. Its properties were farther inveſtigated by Dr Hope, in 1793*, and by Pelletier, Fourcroy, and Vauquelin in 1797†.

1257 Preparation. 2. This earth may be obtained in a ſtate of purity by the following proceſs: A quantity of ſulphate of barytes, a mineral found in conſiderable abundance in nature, is firſt reduced to a fine powder. Mix it with $\frac{1}{8}$th of its weight of charcoal powder, and expoſe the mixture in a crucible to a ſtrong heat, for ſeveral hours. The ſulphuric acid, by this proceſs, is decompoſed, by being deprived of its oxygen, which combines with the carbone of the charcoal, and forms carbonic acid, which is driven off. The ſulphur remains in combination with the earth, forming a ſulphuret of barytes. This ſulphuret is to be diſſolved in water, and nitric acid poured into the ſolution. The nitric acid combines with the barytes, and forms nitrate of barytes, while the ſulphur is precipitated. The ſolution is to be filtered, and ſlowly evaporated till it cryſtallize. The cryſtals thus formed are then put into a crucible, and expoſed to a ſtrong heat. The nitric acid is decompoſed, and driven off, and the earth remains behind in a ſtate of purity.

Dr Hope has recommended another proceſs, which is more economical. By this proceſs the ſulphate of barytes is decompoſed as in the former. The ſulphuret which is obtained, is thrown into water, that all ſoluble matters may be diſſolved. To the ſolution, after filtration, a ſolution of carbonate of ſoda is to be added. A precipitate takes place in the form of a white powder. This powder is to be waſhed with water, made up into balls with charcoal, and expoſed to a ſtrong heat in a crucible. The balls are afterwards to be thrown into boiling water, when part of the barytes is found diſſolved, and, as the water cools, it cryſtallizes.

1258 Properties. 3. Barytes, as it is obtained by decompoſing the nitrate in the firſt proceſs, is in the form of ſmall, gray, porous maſſes, which are eaſily reduced to powder. It has a hot, burning taſte; and, when introduced into the ſtomach, is a deadly poiſon. Its ſpecific gravity is 4.00. It deſtroys the texture of all animal ſubſtances. It converts vegetable blues to a green colour. In many of its properties it is perfectly analogous to the fixed alkalies.

1259 Action of water. 4. When it is expoſed to the air, eſpecially if the atmoſphere be loaded with moiſture, it ſwells up in a few minutes, becomes hot, and at laſt falls into a white powder. It is then deprived of part of its acrimony, and is increaſed in weight 0.22. This is owing to the abſorption of water from the atmoſphere. If a ſmall quantity of water be thrown upon barytes, it boils up, is ſtrongly heated, is enlarged in volume, and gives out a great quantity of heat. After being ſlaked in this manner, it is diluted with water, the earth cryſtallizes, and aſſumes the appearance of needle-formed cryſtals, which, at the end of ſome time, if expoſed to the air, ſpontaneouſly fall to powder. With a greater quantity of water the barytes is completely diſſolved. Cold water takes up about $\frac{1}{20}$ of its weight. This ſolution changes the ſyrup of violets to green, and at laſt deſtroys the colour. When this liquid is expoſed to the air, a thick pellicle is formed on the ſurface, which is owing to the abſorption of carbonic acid from the atmoſphere. Boiling water diſſolves $\frac{1}{2}$ its weight of pure barytes. The ſolution affords cryſtals as it cools. They are in the form of long, four-ſided priſms, tranſparent and white, which effloreſce in the air; but the form of the cryſtals varies according to the rapidity of the evaporation and cryſtallization.

1260 Of heat. 5. Light has no action on barytes. Heated on charcoal with the blow-pipe, it melts into an opaque, gray globule, which ſoon penetrates the charcoal. Expoſed to heat in a crucible, it melts, and attaches itſelf to the ſides of the veſſel, to which it adheres ſtrongly, forming a kind of greeniſh covering. Leſs ſtrongly heated, it hardens, and internally aſſumes a bluiſh green ſhade. There is no action between barytes and oxygen, azote, hydrogen, or carbone.

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* Edin. Tranſ. iv. 36.

† Ann. de Chim. xxi. 113.

I. Phoſphuret of Barytes.

1261 Preparation. 1. Barytes enters into combination with phoſphorus, forming the compound called *phoſphuret of barytes.* This is prepared by introducing a mixture of barytes and phoſphorus into a glaſs tube cloſed at one end, and expoſing the mixture to the heat of burning coals. The two ſubſtances rapidly combine together.

1262 Properties. 2. The phoſphuret of barytes, thus obtained, is of a dark or ſhining brown colour, having a metallic appearance, very fuſible, and exhaling, when it is moiſtened, a ſtrong fetid odour: in the dark it is luminous. When it is thrown into water, it is decompoſed, giving out phoſphorated hydrogen gas, and is gradually converted, by the action of the air and the water, into *phoſphate of barytes* *.

II. Sulphuret of Barytes.

1263 Preparation. 1. A ſimilar combination alſo takes place between barytes and ſulphur. This combination may be formed by introducing barytes and ſulphur well mixed together, into a crucible, and expoſing them to a red-heat. At that temperature the mixture melts, and the compound which is formed is the ſulphuret of barytes.

1264 Properties. 2. This ſubſtance is very ſoluble in water, which it inſtantly decompoſes; and, when it is ſaturated with the ſulphurated hydrogen which is formed, it is converted 1265 Hydrogenated ſulphuret. into a hydrogenated ſulphuret of barytes, which depoſits by cooling, cryſtals of different forms, ſometimes in that of ſmall needles, ſometimes in that of large ſix-ſided priſms, ſometimes in the form of octahedrons, and often in that of ſmall, brilliant, hexagonal plates, which are cryſtals of ſulphurated hydrogen and barytes, denominated by Berthollet, *hydroſulphuret of barytes.* When the ſulphuret of barytes is diſſolved in water, it inſtantly exhales the fetid odour of ſulphurated hydrogen gas. The liquid which has depoſited cryſtals of hydroſulphuret of barytes, retains a hydrogenated ſulphuret in ſolution. When it is expoſed to the air, this ſolution becomes of an orange yellow. Cryſtals of hydroſulphuret of barytes, with ſpots or yellowiſh plates, are often obſerved in the midſt of the white maſſes.

3. The ſulphuret of barytes is moſt remarkable for the great rapidity with which it decompoſes water, and the great quantity of the ſulphurated hydrogen with which it combines, forming the hydroſulphuret of barytes; which latter is ſlowly, and with difficulty, decompoſed by the air, and the great proportion of ſulphurated hydrogen gas which is diſengaged by the action of acids, without any precipitation of ſulphur.

1266 Three compounds. 4. Thus, there are three different combinations of ſulphur with barytes. In the firſt, the ſulphur is directly combined with the barytes, as when they are expoſed to heat in the ſtate of dryneſs, which is the ſimple ſulphuret of barytes. In the other, the ſulphur combined with the hydrogen, is in the ſtate of hydroſulphuret of barytes. This compound is prepared by paſſing ſulphurated hydrogen gas into water holding barytes in ſolution, which, as it combines with the gas, becomes more ſoluble, and is condenſed and abſorbed by the water. The diſtinctive character between the latter combination and that of the ſulphuret of barytes is, that the firſt, by the action of acids, only gives out ſulphurated hydrogen gas, without any depoſition of ſulphur; and the ſecond, expoſed to heat, is deprived of its ſulphur, which is ſublimed, without affording ſulphurated hydrogen gas. Between theſe two ſtates, there is an intermediate combination, in which the ſulphuret of barytes holds in ſolution more or leſs ſulphurated hydrogen; ſo that, by the action of acids, it affords ſulphurated hydrogen gas, with a depoſition of ſulphur at the ſame time. To this intermediate compound, Berthollet has given the name of *hydrogenated ſulphuret of barytes* *.

III. Compounds of Barytes with the Acids.

1267 Affinities. Barytes enters into combination with the acids, and forms with them compounds, which are diſtinguiſhed by the name of *ſalts*. The order of the affinities of barytes for the acids, according to Bergman, is the following.

Sulphuric acid,
Oxalic,
Succinic,
Fluoric,
Phoſphoric,
Saclactic,
Nitric,
Muriatic,
Suberic,
Citric,
Tartaric,
Arſenic,
Lactic,
Benzoic,
Acetic,
Boracic,
Sulphurous,
Carbonic,
Pruſſic.

1. Sulphate of Barytes.

1268 Found native. 1. This ſalt, which is a compound of ſulphuric acid and barytes, was formerly diſtinguiſhed by the name of *heavy ſpar*, *phoſphoric ſpar*, or *Bolognian ſtone*. It exiſts in great abundance in nature, particularly accompanying metallic veins; from which circumſtance, probably, and from its great weight, it was ſuppoſed to contain a metallic ſubſtance. It is rarely formed artificially, as that found in nature is ſufficiently pure.

1269 Properties. 2. The ſulphate of barytes is the heavieſt of all the ſalts, the ſpecific gravity being 4.4. It has neither taſte nor ſmell. Sometimes it is found cryſtallized, and ſometimes compact. There is a conſiderable variety among the forms of its cryſtals. The primitive form of ſulphate of barytes is a rhomboid, with right angles at the baſes, whoſe angles are $101\frac{1}{2}^{\circ}$ and $78\frac{1}{2}^{\circ}$. The integrant molecule is the ſame.

1270 Action of heat. 3. This ſalt remains unchanged in the air, and it is inſoluble in water. When it is ſuddenly heated, it decrepitates. By the action of a ſtrong heat, it melts with difficulty; and before the blow-pipe it fuſes, and is converted into a white opaque globule. It is decompoſed at a red heat by hydrogen and charcoal, and is converted into a ſulphuret which is phoſphoric. This was formerly called, from an accident, *Bolognian phoſphorus.*

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* Fourcroy Connaiſs. Chim. ii. p. 191.

* Fourcroy Connaiſs. Chim. ii. p. 191.

phoſphorus. A piece of the ſulphate of barytes was found in the neighbourhood of Bologna, by a ſhoemaker of that city, who ſuſpecting that it contained ſilver, put it into the fire to ſeparate the metal. He found no metal, but he obſerved that by heating it acquired the property of ſhining in the dark, and thence it obtained the name of Bolognian ſtone or phoſphorus.

This ſalt is decompoſed by the carbonates of potaſh and ſoda, either by expoſing them to a ſtrong heat in a crucible, or by boiling them together in ſolution.

1271 Compoſition. According to the different analyſes which have been made to aſcertain the conſtituents of this ſalt, it appears that there is a conſiderable difference between the natural and artificial ſulphate of barytes, as in the following table.

	Native.	Artificial.
Acid	13	33
Barytes	84	64
Water	3	3
	100	100 *.

By another analyſis, when the artificial ſulphate was heated to redneſs, the component parts were found according to

	Thenard †.	Chenevix ‡.
Acid	25.18	24
Barytes	74.82	76
	100.00	100

2. Sulphite of Barytes.

1272 Preparation. 1. This compound of ſulphurous acid and barytes, is formed by paſſing ſulphurous acid gas into water, in which is mixed, or ſuſpended, carbonate of barytes in the ſtate of fine powder; or by the direct combination of ſulphurous acid and barytes, either ſolid or in ſolution. In whatever way it is prepared, the ſalt is depoſited in the form of powder, or cryſtallized.

1273 Properties. 2. The cryſtals of ſulphate of barytes are ſometimes in the form of ſmall, brilliant, and opaque needles, or very hard tranſparent cryſtals in the form of tetrahedrons, with truncated angles. It has little taſte. The ſpecific gravity is 1.6938. It is ſcarcely altered when expoſed to the air, and is inſoluble in water. When it is expoſed to heat, ſulphur is driven off, and there remains a ſulphate of barytes. It is decompoſed by the ſulphuric and muriatic acids, with the diſengagement of ſulphurous acid.

1274 Uſes. 3. This ſalt has been applied to no uſe, excepting for the chemical purpoſe of aſcertaining the purity of ſulphurous acid. It is employed in this way by Fourcroy. If there be any mixture of ſulphurous acid with the ſulphuric, it may be detected by this ſalt; for as there is a ſtronger affinity between ſulphuric acid and barytes than between ſulphurous acid and the ſame earth, the ſulphuric acid, if any be preſent, combines with the barytes, and forms with it an inſoluble ſalt, which is precipitated.

1275 Compoſition. 4. The following are the proportions of the conſtituent parts of this ſalt.

Sulphurous acid	39
Barytes	59
Water	2
	100 *

3. Nitrate of Barytes.

1276 Preparation. 1. This compound of nitric acid and barytes is prepared by ſaturating the acid with native carbonate of barytes; or, by the decompoſition of ſulphuret of barytes, by nitric acid. By filtration and evaporation this ſalt cryſtallizes.

1277 Properties. 2. The cryſtals of nitrate of barytes are in the form of regular octahedrons, or in ſmall brilliant plates. The ſpecific gravity is 2.9149. It has a hot, acrid, and auſtere taſte, and is little changed by being expoſed to the air. It is ſoluble in 12 parts of cold, and in about three or four parts of boiling water. When placed upon burning coals, it decrepitates, boils up, and becomes dry, and gives out ſparks round the points where it comes in contact with the burning coal. When it is heated in a retort, it gives out a little water, oxygen gas, and azotic gas; and there remains behind, the barytes in the form of a ſolid, gray, porous maſs.

1278 Compoſition. The conſtituent parts of this ſalt, according to Fourcroy, Vauquelin, and Kirwan, are the following:

	Fourcroy and Vauquelin †.	Kirwan ‡.
Nitric acid	38	32
Barytes,	50	57
Water,	12	11
	100	100

This ſalt is only employed for detecting ſulphuric acid in nitric acid, and to be decompoſed for the purpoſe of obtaining pure barytes.

4. Nitrite of Barytes.

Nothing farther is known of this ſalt, than that it is formed when the nitrate of barytes is decompoſed in a retort by means of heat. If the operation be ſtopped at the time that a third part of the oxygen gas has been diſengaged, the nitrite of barytes remains.

5. Muriate of Barytes.

1279 Hiſtory. 1. This ſalt, which is a compound of muriatic acid and barytes, was firſt inveſtigated by Scheele and Bergman, and little more has been ſince added by the experiments and reſearches of other chemiſts.

1280 Preparation. 2. It is prepared by the direct combination of muriatic acid with the carbonate of barytes; or, by decompoſing the ſulphuret of barytes by the muriatic acid, filtering the ſolution, and evaporating till a pellicle appear on the ſurface. If it be allowed to cool ſlowly, cryſtals of muriate of barytes are formed. But the ſulphate of barytes, which is employed, ſometimes contains iron; ſo that a muriate of this metal is formed along with the muriate of barytes. To ſeparate the iron, the mixture is to be calcined, by which the acid is driven off, and the iron remains behind in the ſtate of oxide, which is inſoluble in water.

1281 Properties. 3. The primitve form of the cryſtals of this ſalt is a four-ſided priſm with ſquare baſes. The form of the integrant particle is the ſame. It cryſtallizes in tables, or in eight-ſided pyramids. The taſte is acrid, aſtringent, and metallic. The ſpecific gravity is 2.8257.

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* Fourcroy Connaiſs. Chim. iii. p. 25.

† Ann. de Chim. xxxii. p. 260.

‡ Nichol. Jour. ii. 8vo. p. 196.

* Fourcroy Connaiſs. Chim. iii. p. 75.

† Ibid. iii. p. 106.

‡ Nichol. Jour. iii. p. 115.

1282 Action of water. 4. It undergoes no change by expoſure to the air. It is ſoluble in five or ſix parts of cold water, but boiling water diſſolves more; and, on cooling, the ſalt cryſtallizes.

1283 Of heat. 5. When expoſed to heat, it decrepitates, loſes its water of cryſtallization, dries, falls down to powder, and at laſt melts; but no heat that can be applied decompoſes it.

1284 Of acids. 6. This ſalt is decompoſed by the ſulphuric and nitric acids, and a precipitation of nitrate or of ſulphate of barytes is formed.

1285 Compoſition. 7. The conſtituent parts of this ſalt, according to Mr Kirwan, are,

		When dried,
Acid,	20	23.8
Barytes,	64	76.2
Water,	16	00.0
	100	100.0

1286 Uſes. 8. This is one of the moſt delicate teſts for detecting ſulphuric acid in any ſolution. Water, which holds 0.0002 parts of ſulphuric acid, exhibits a viſible precipitate by a ſingle drop of the ſolution of muriate of barytes. Nay, there is a ſlight cloud in a few minutes produced by the addition of a ſolution of this ſalt to water which holds 0.00009 parts of ſulphuric acid in ſolution. The muriate of barytes has been propoſed and recommended as a cure for ſcrophula; and it is ſaid, in ſome caſes in which it has been uſed, with good effect; but it ought to be adminiſtered with the utmoſt caution. The carbonate of barytes is one of the moſt active poiſons, and probably all the ſalts of this earth are poſſeſſed of ſimilar properties. The doſe ſhould not exceed five or ſix drops of the ſolution at firſt *.

6. Hyperoxymuriate of Barytes.

1287 Preparation. 1. The compound of hyperoxymuriatic acid and barytes was formed by Mr Chenevix. The proceſs which he followed was, to cauſe a current of oxymuriatic acid gas to paſs through a ſolution of a large quantity of barytic earth in warm water. This ſalt he found ſoluble in four parts of cold, and leſs of warm water; but as it cryſtallizes like the muriate of this earth, and has the ſame degree of ſolubility, he could not ſeparate the hyperoxymuriate from the muriate, which was formed at the ſame time. He therefore thought of obtaining it by double affinity, as in the following proceſs.

2. When phoſphate of ſilver is boiled with muriate of barytes, a double decompoſition takes place; muriate of ſilver and phoſphate of barytes are formed, both of which being inſoluble, are precipitated. But the phoſphate of ſilver does not decompoſe the hyperoxymuriate of barytes. When therefore the muriate and hyperoxymuriate of barytes are boiled with phoſphate of ſilver, the muriate of barytes only is decompoſed. The muriate of ſilver and the phoſphate of barytes are precipitated, and the hyperoxymuriate of barytes remains in ſolution. When this ſalt is decompoſed by the ſtronger acids, it is accompanied with a flaſh of light, which Mr Chenevix conjectures, is owing to the relative proportionate affinities, and conſequently the greater rapidity of the diſengagement.

1288 Compoſition. The proportions of this ſalt are,

Hyperoxymuriatic acid,	47.0
Barytes,	42.2
Water,	10.8
	100.0 *.

7. Fluate of Barytes.

This compound of fluoric acid and barytes may be formed, by pouring fluoric acid into a ſolution of nitrate or muriate of barytes. A precipitate is formed, which is the fluate of barytes. This ſalt is decompoſed with effervescence by the ſulphuric acid, and it is precipitated by lime water. Of the proportions of its conſtituent parts and other properties nothing is known.

8. Borate of Barytes.

The compound of boracic acid and barytes is formed by pouring a ſolution of boracic acid into a ſolution of barytes. An inſoluble white powder is precipitated, which, according to Bergman, may be decompoſed, even by the weak vegetable acids.

9. Phoſphate of Barytes.

1289 Preparation. 1. The compound of phoſphoric acid and barytes, has been only examined by Vauquelin. It is prepared, either by the direct combination of phoſphoric acid with barytes, or the carbonate of barytes; or by precipitating a ſolution of nitrate or muriate of barytes, by means of an alkaline phoſphate. The phoſphate of barytes is precipitated in the form of powder.

1290 Properties. 2. This ſalt is in the form of white powder, without any appearance of cryſtallization. It is not altered by expoſure to the air, and is inſoluble in water. The ſpecific gravity is 1.2867.

1291 Action of heat. 3. This ſalt at a high temperature is fuſible. It is converted into a vitreous matter or gray enamel. Before the blow-pipe, on charcoal, it gives out a yellow phoſphoric light. The vitreous globules become opaque on cooling. It is decompoſed by the ſulphuric acid. The phoſphoric and phoſphorous acids, when added in exceſs, have the property of re-diſſolving the ſalts which they form with barytes.

10. Phoſphite of Barytes.

1292 Preparation. This compound of phoſphorous acid and barytes, is formed by the direct combination of the acid with the earth; or by precipitating the ſoluble phoſphites by a ſolution of barytes. By the laſt proceſs the ſalt is obtained in the greateſt purity.

1293 Properties. 2. The phoſphite of barytes is in the form of a white powder, which is inſipid, not altered by expoſure to the air, not very ſoluble in water, and without an exceſs of acid, by which means it is converted into the acidulous phoſphite.

1294 Action of heat. 3. The phoſphite of barytes melts under the blow-pipe into a globule, which is ſoon ſurrounded with a moſt brilliant light. The vitreous globule becomes, on cooling, white and opaque.

1295 Of acids. 4. This ſalt is decompoſed by moſt of the acids; by lime

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* Fourcroy Connaiſſ. Chim. iii. p. 167.

* Phil. Tranſ. 1802. p. 147.

lime and lime water. The other alkaline and earthy baſes combine with the exceſs of phoſphorous acid, when it is in the ſtate of acidulous phoſphate, and there remains behind a neutral phoſphite.

1296 Compoſition. 5. The component parts of this ſalt are,

Phoſphorous acid,	41.7
Barytes,	51.3
Water,	7.0
	100.0 *.

11. Carbonate of Barytes.

1297 Names. 1. This compound of carbonic acid and barytes has been known by the names of *aërated heavy ſpar*, *aërated baroſelenite*, and *witherite* from the name of Dr Withering, who firſt diſcovered that it is a natural production. Its nature and properties were firſt inveſtigated by Scheele and Bergman, about the year 1776, and ſince that time by Kirwan, Hope, Klaproth, Pelletier, Fourcroy, and Vauquelin.

1298 Native. 2. The carbonate of barytes is found native in ſtriated, lamellated, ſemitranſparent maſſes. The primitive form of its cryſtals is the ſix-ſided priſm. The ſpecific gravity is 4.331.

1299 Prepared by art. 3. The carbonate of barytes may be prepared artificially, by expoſing a ſolution of pure barytes to the air; or, by paſſing carbonic acid gas into the ſolution. It may be prepared alſo in the dry way, by mixing together ſulphate of barytes and carbonate of potaſh or ſoda, and expoſing the mixture to ſtrong heat: or, by decompoſing by means of carbonate of potaſh, ſoda, or ammonia, the nitrate or muriate of barytes in ſolution in water. By whatever proceſſes the carbonate of barytes is obtained, it is in the form of a white taſteleſs powder. When thus prepared, the ſpecific gravity is 3.763.

4. It undergoes no change by expoſure to the air. Cold water diſſolves $\frac{1}{4304}$; boiling water $\frac{1}{2304}$ part.

1300 Action of heat. 5. The carbonate of barytes undergoes little change when it is expoſed even to the ſtrongeſt heat. The artificial carbonate loſes about 0.28 of its weight by calcination, while the native carbonate becomes white and opaque, and is converted into a bluiſh green colour, without any perceptible loſs of weight; but if it be heated in a black lead crucible, or if it be formed into a paſte, with 100 parts of the ſalt to 10 of charcoal, the carbonic acid is ſeparated.

1301 Compoſition. 6. The component parts of the carbonate of barytes are the following:

Native Carbonate.

	Withering.	Fourcroy.
Acid	20	10
Barytes	80	90
	100	100

Artificial Carbonate.

	Bergman,	Pelletier.
Acid	7	22
Barytes	65	62
Water	28	16
	100	100

When both the natural and artificial are expoſed to a red heat, the component parts, as aſcertained by Mr Kirwan, are,

Acid	22
Barytes	78
	100

1302 Uſes. 7. This ſalt has been found native only in ſmall quantity, otherwiſe it is ſuppoſed, that it might be of great uſe for the preparation of barytic ſalts, which promiſe great ſervice in ſeveral arts and manufactures. It has been propoſed to employ it in medicine; but in experiments on animals, it has been found to act as a moſt deadly poiſon. Great caution, therefore, ſhould be obſerved in employing it as an internal remedy *.

12. Arſeniate of Barytes.

The compound of arſenic acid and barytes is formed by diſſolving the earth in the acid. It is an inſoluble, uncryſtallized ſalt; but with an exceſs of acid it becomes ſoluble, and is decompoſed by ſulphuric acid. It melts when expoſed to a ſtrong heat, but is not decompoſed.

13. Tungſtate of Barytes.

With the tungſtic acid barytes forms an inſoluble ſalt.

14. Molybdate of Barytes.

Barytes with the molybdic acid forms a ſalt which has very little ſolubility.

15. Chromate of Barytes.

It is little known, but ſaid to be inſoluble in water.

16. Columbate of Barytes.

17. Acetate of Barytes.

1203 Preparation. 1. This ſalt, which is a compound of acetic acid and barytes, may be prepared by directly combining the acid with the earth; or, by decompoſing ſulphuret of barytes by means of acetic acid. By evaporating the ſolution, it may be obtained cryſtallized.

1304 Properties. 2. The cryſtals of the acetate of barytes are in the form of fine tranſparent priſms. The ſpecific gravity is 1.828. This ſalt has an acid bitter taſte, effloreſces in the air, is very ſoluble in water, is decompoſed by the carbonates of the alkalies, but not by the alkalies themſelves, or the pure earths.

1305 Uſes. 3. This ſalt may be employed to detect the preſence and quantity of ſulphuric acid in ſolutions, particularly in vinegar, which may be adulterated with the addition of this acid ‡.

18. Oxalate of Barytes.

1306 Preparation. 1. The compound of oxalic acid and barytes is formed by adding the acid to a ſolution of barytes in water. A white powder precipitates, which is oxalate of barytes; it is inſoluble in water. With an exceſs of oxalic acid, this precipitate is diſſolved, and ſmall angular cryſtals are formed.

1307 Action of heat. 2. If theſe cryſtals are diſſolved in boiling water, they become opaque, and fall down in the form of an inſoluble powder, for the water combines with the exceſs of acid, which held them in ſolution.

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* *Fourcroy Connaiſs. Chim.* iii. p. 281.

* *Fourcroy*, iv. 10.

‡ *Fourcroy*, viii. 196.

19. Tartrate of Barytes.

The compound of tartaric acid and barytes forms a ſalt in the ſtate of white powder, which has little ſolubility, excepting with an exceſs of acid. It is decompoſed by the ſulphuric, nitric, muriatic, and oxalic acids.

20. Citrate of Barytes.

1308 Preparation. 1. The compound of citric acid and barytes forms a ſalt, by adding the earth to a ſolution of the acid. A flocculent precipitate at firſt appears, which is diſſolved by agitation. The precipitate afterwards becomes permanent when the acid is ſaturated.

2. This ſalt, which is at firſt depoſited in the form of powder, ſhoots out afterwards into a kind of vegetation, of a ſilvery whiteneſs, with great brilliancy and beauty. It is ſoluble in a great proportion of water. This ſalt is compoſed of

Acid,	50
Barytes,	50
	100

21. Malate of Barytes.

The compound of malic acid and barytes is formed by adding the acid to a ſolution of the earth in water. A cryſtallized, ſoluble ſalt is precipitated.

22. Gallate of Barytes.

The compound of gallic acid and barytes is formed by the direct combination of the acid with the earth. A ſalt is thus formed, which is not very ſoluble, but with an exceſs of the baſe.

23. Benzoate of Barytes.

Benzoic acid combines with barytes, and forms a ſalt which is ſoluble in water, cryſtallizes, undergoes no change by expoſure to the air, and is decompoſed by heat and the ſtronger acids.

24. Succinate of Barytes.

Barytes forms, with ſuccinic acid, a ſalt which has little ſolubility.

25. Saccolate of Barytes.

This ſalt is inſoluble in water.

26. Camphorate of Barytes.

1309 Preparation. 1. The compound of camphoric acid and barytes is formed by adding the cryſtallized acid to the ſolution of the earth, and then boiling the mixture. It is afterwards to be filtered and evaporated to dryneſs. What remains is camphorate of barytes.

1310 Properties. 2. This ſalt does not cryſtallize; but when it is ſlowly evaporated, ſmall plates are depoſited, which ſeem tranſparent in the liquid, but become opaque when expoſed to the air. It has ſcarcely any taſte; but an impreſſion remains on the tongue, which is ſlightly acid and bitter.

3. This ſalt undergoes no change by expoſure to the air. It is only ſoluble in 600 parts of water at the boiling temperature.

1311 Action of heat. 4. When expoſed to the action of the blow-pipe, the acid is volatilized, and the earth is converted into a vitreous ſubſtance. The camphoric acid, as it burns, firſt exhibits a blue, then a red, and at laſt, a white flame.

5. This ſalt is decompoſed by the ſulphuric, nitric, and muriatic acids, and by the oxalic, tartaric and citric *.

27. Suberate of Barytes.

This ſalt does not cryſtallize, and is only ſoluble in water with an exceſs of acid; when expoſed to heat, it ſwells up and melts, and is decompoſed by the ſulphuric, nitric, muriatic, and oxalic acids †.

28. Mellate of Barytes.

By adding mellitic acid to a ſolution of acetate of barytes, there is formed a flaky precipitate which is re-diſſolved with the addition of more acid. When the acid is poured into a ſolution of muriate of barytes no precipitate is formed; but a ſhort time afterwards a group of tranſparent needle-formed cryſtals is depoſited.

29. Lactate of Barytes.

Barytes forms with lactic acid, a deliqueſcent ſalt.

30. Pruſſiate of Barytes.

Pruſſic acid and barytes form a ſalt which is very little ſoluble in water, and is decompoſed, not only by the ſulphuric acid but even by carbonic.

31. Sebate of Barytes.

Sebacic acid added to a ſolution of barytes in water, forms no precipitate; from which it is inferred that the ſebate of barytes is ſoluble in water.

Sect. III. *Of Strontites and its Combinations.*

1312 Hiſtory. 1. This earth was not diſcovered till about the year 1791 or 1792. Dr Crawford, indeed, previous to this period, in making ſome experiments on what he ſuppoſed was a carbonate of barytes, and obſerving a ſtriking difference between this mineral, and the carbonate of barytes which he had been accuſtomed to employ, conjectured that it might contain a new earth; and he ſent a ſpecimen to Mr Kirwan for the purpoſe of analyzing it. This conjecture was fully verified by the experiments of Dr Hope ‡, Mr Kirwan, and M. Klaproth, who were all engaged in the ſame analyſis nearly about the ſame time. Strontites is found native in combination with carbonic and ſulphuric acids. With the former it is found in conſiderable quantity in the lead mines of Strontian in Argyleſhire, from which it has derived its name *ſtrontites*, or *ſtrontian* as it is called by others. The nature and properties of this earth have been ſtill farther inveſtigated by Pelletier, Fourcroy, and Vauquelin.

1313 Preparation. 2. This earth may be obtained in a ſtate of purity, either by expoſing the carbonate of ſtrontites, mixed with charcoal powder, to a ſtrong heat, by which the carbonic acid is driven off; or, by diſſolving the native ſalt in nitric acid, and decompoſing the nitrate of ſtrontites thus formed, by heat. Strontites obtained by either of theſe proceſſes, is in ſmall porous fragments of a greeniſh white colour. 1314 Properties. It has an acrid, hot, alkaline taſte, and converts vegetable blues to green. The ſpecific gravity is 1.647.

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* *Ann. de Chim.* xxvii. p. 28

† *Ibid.* xxiii. 52.

‡ *Edin. Tranſ.* iv. 3.

1315 Action of heat. 3. Light has no perceptible action upon this earth. When it is expoſed to heat, it may be kept a long time, even in a red heat, without undergoing any change, or even the appearance of fuſion. By the action of the blow-pipe it is not melted, but is ſurrounded with a very brilliant white flame.

1316 Of water. 4. When a little water is thrown on ſtrontites, it exhibits the ſame appearance as barytes. It is ſlaked, gives out heat, and then falls to powder. If a greater quantity of water be added, it is diſſolved. According to Klaproth it requires 200 parts of water at the ordinary temperature of the atmoſphere for its ſolution. Boiling water diſſolves it in greater quantity, and when the ſolution cools, it affords tranſparent cryſtals. Theſe cryſtals are in the form of rhomboidal plates, or in that of flattened ſilky needles, or compreſſed priſms. The ſpecific gravity is 1.46. Theſe cryſtals effloreſce in the air, and have an acrid hot taſte. The ſolution of this earth in water is acrid and alkaline, and converts vegetable blues to green. It is ſoon covered with a pellicle, by abſorbing carbonic acid from the atmoſphere.

5. Strontites has the property of communicating a purple colour to flame.

1317 Affinities. 6. The order of the affinities of ſtrontites is the following.

Sulphuric acid,
Phoſphoric,
Oxalic,
Tartaric,
Fluoric,
Nitric,
Muriatic,
Succinic,
Acetic,
Arſenic,
Boracic,
Carbonic.

I. Phoſphuret of Strontites.

The phoſphuret of ſtrontites is prepared in the ſame way as the phoſphuret of barytes.

II. Sulphuret of Strontites.

1318 Preparation. The ſulphuret of ſtrontites is formed by expoſing ſulphur and the earth in a crucible, to heat. This ſulphuret is ſoluble in water, by means of ſulphurated hydrogen, which is diſengaged by the decompoſition of the water. The ſtrontites thus combined with ſulphurated hydrogen, forms a hydroſulphuret of ſtrontites; and if this ſolution be evaporated, the hydroſulphuret of ſtrontites may be obtained in cryſtals, and the hydrogenated ſulphuret remains, as in ſimilar compounds, in ſolution. When the hydrogenated ſulphuret is decompoſed by means of an acid, the ſulphurated hydrogen gas which is diſengaged, burns with a beautiful purple flame, on account of holding in ſolution a ſmall quantity of the earth, which communicates this property.

III. Compounds of Strontites with the Acids.

1. Sulphate of Strontites.

1. The compound of ſulphuric acid with ſtrontites, may be formed by adding ſulphuric acid to a ſolution of ſtrontites in water, and it is obtained in the ſtate of a white powder. It is found native in different places, cryſtallized in fine needle-formed priſms. It has no taſte, and is ſcarcely ſoluble in water. It ſuffers no change in the air. By the action of the blow-pipe it gives out a yellowiſh purple light. It is not decompoſed by any of the acids; but it is decompoſed by the carbonate of potaſh and ſoda, by the barytic ſalts, by the ſulphates of potaſh and of ſoda, the phoſphates of potaſh, ſoda, and ammonia, and by the borate of ammonia.

2. The component parts of this ſalt, according to Vauquelin, are,

Acid,	46
Strontites,	54
	100

But according to Klaproth, Kirwan, and others,

Acid,	42
Strontites,	58
	100

2. Sulphite of Strontites.

This ſalt is yet unknown.

3. Nitrate of Strontites.

1. The compound of nitric acid and ſtrontites, is formed by precipitating, by means of nitric acid, the ſulphuret of ſtrontites, obtained from the decompoſed ſulphate, or by diſſolving the carbonate of ſtrontites in the acid. By evaporation it may be obtained in cryſtals.

2. The cryſtals of nitrate of ſtrontites are in the form of octahedrons. The taſte of this ſalt is cool and pungent. It is not altered by expoſure to the air. The ſpecific gravity is 3.0061. It is ſoluble in 15 parts of cold water, and much more ſoluble in boiling water, in which it cryſtallizes on cooling. Expoſed to ſudden heat it decrepitates. When it is ſubjected to heat in a crucible, it ſwells up, gives out oxygen and nitrous gas, and there remains behind pure earth. This ſalt has the property of communicating a purple flame to combuſtible ſubſtances with which it is mixed; as when a little of the ſalt in powder is thrown on the wick of a candle.

3. The component parts of this ſalt are, according to

	Vauquelin.	Kirwan.
Acid	48.4	31.7
Strontites	47.6	36.21
Water	4.0	32.72
	100.0	100.00

4. Nitrite of Strontites.

The properties of this ſalt have not been examined.

5. Muriate

5. Muriate of Strontites.

1319 Preparation. 1. The compound of muriatic acid and ſtrontites is prepared by diſſolving carbonate of ſtrontites in the acid. By evaporating the ſolution, the ſalt is obtained cryſtallized.

1320 Properties. 2. This ſalt cryſtallizes in long, ſlender, hexagonal priſms. The taſte is cooling and pungent. The ſpecific gravity is 1.4402. It is not altered by expoſure to the air. It is very ſoluble in water. Three parts of the ſalt are diſſolved in two parts of cold water. Theſe cryſtals, which are ſoluble in alcohol, communicate a purple colour, which is the diſtinguiſhing characteriſtic of this ſalt. When heated, it melts, and parts with its water of cryſtallization, without being decompoſed, and there remains behind a ſemitranſparent enamel. This ſalt is decompoſed by a very ſtrong heat. It it decompoſed alſo by the ſulphuric, nitric, and phoſphoric acids; and by potaſh, ſoda, and barytes.

1321 Compoſition. 3. The conſtituent parts of this ſalt are, according to

	Vauquelin.	Kirwan.
Acid	23.6	18
Strontites	36.4	40
Water	40.0	42
	100.0	100

6. Hyperoxymuriate of Strontites.

1322 Preparation. 1. This combination of hyperoxymuriatic acid and ſtrontites, was prepared by Mr Chenevix, by a ſimilar proceſs to that which he employed in the formation of barytes with the ſame acid; and in many of its properties it is analogous.

1323 Compoſition. 2. The cryſtals of this ſalt are in the form of needles. They melt in the mouth, and give the ſenſation of cold. It is compoſed of

Acid	46
Strontites	26
Water	28
	100 *

7. Fluate of Strontites.

The properties of this ſalt have not yet been inveſtigated.

8, Borate of Strontites.

This compound of boracic acid and ſtrontites, is in the form of a white powder, and requires 130 parts of water for its ſolution. It converts the ſyrup of violets to a green colour, from which it is inferred, that it contains an exceſs of the earth.

9. Phoſphate of Strontites.

1324 Preparation. 1. The compound of phoſphoric acid and ſtrontites, is formed by diſſolving the carbonate of the earth in acid; or, by mixing together the ſolutions of muriate of ſtrontites, with thoſe of the alkaline phoſphates.

1325 Properties. 2. It is thus obtained in the form of white powder, which is perfectly taſteleſs. It is not altered by expoſure to the air. It is inſoluble in water, without an exceſs of acid. It melts under the blow-pipe into a white enamel, and gives out a purple, phoſphoreſcent light.

3. The conſtituent parts of this ſalt are,

Acid	41.24
Strontites	58.76
	100.00

10. Phoſphite of Strontites.

The nature of this ſalt is unknown.

11. Carbonate of Strontites.

1326 Found native. 1. This ſalt is found native; and, as we have already mentioned, was pointed out by Dr Crawford as different from the carbonate of barytes, with which it had been formerly confounded.

1327 Preparation. 2. It may be prepared artificially, by ſaturating a ſolution of ſtrontites in water with carbonic acid; or, by precipitating ſoluble ſalts with a baſe of this earth, by means of alkaline carbonates. The carbonate of barytes cryſtallizes in needles, or in ſix-ſided priſms. It has no taſte. The ſpecific gravity is 3.6750. It is not changed by expoſure to the air, and it is nearly inſoluble in water. 1328 Properties. When it is ſtrongly heated in a crucible, to produce fuſion, it is deprived of part of its carbonic acid. When heated under the blow-pipe, it melts into an opaque, vitreous globule, and gives out a purple flame.

1329 Compoſition. 3. The component parts of this ſalt, according to different chemiſts, are

	Hope.	Klaproth and Kirwan.	Pelletier.
Acid	30.2	30.	30
Strontites	61.2	69.5	62
Water	8.6	0.5	8
	100.0	100.0	100

12. Arſeniate of Strontites.

When arſenic acid is dropped into a ſolution of ſtrontites in water, a copious precipitate is formed, which is re-diſſolved when there is an exceſs of acid. When the arſeniate of ſtrontites is neutralized, it is only in a ſlight degree ſoluble in water *.

13. Tungſtate of Strontites. 14. Molybdate of Strontites. 15. Chromate of Strontites. 16. Columbate of Strontites.	Unknown.

17. Acetate of Strontites.

1330 Preparation. 1. This compound of acetic acid and ſtrontites is formed by diſſolving the carbonate in the acid. By evaporation the ſalt may be obtained cryſtallized.

1331 Properties. 2. The cryſtals remain unaltered by expoſure to the air. They change vegetable blues to green, and are equally ſoluble in hot and cold water †.

18. Oxalate of Strontites.

The compound of oxalic acid and ſtrontites is formed by the direct combination of the acid with the earth in ſolution. A precipitate appears in the form of a white powder, which is nearly inſoluble in water. It is decompoſed by heat.

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* *Phil. Tranſ.* 1802.

* *Edin. Tranſ.* iv. 17.

† *Edin. Tranſ.* iv. p. 14.

The component parts of this ſalt are,

Acid	40.5
Strontites	59.5
	100.0

19. Tartrate of Strontites.

1. This ſalt is formed by diſſolving the earth in the acid. The cryſtals are in the form of ſmall triangular tables; they are not altered by the air, are inſipid to the taſte, and ſoluble in 320 parts of boiling water.

2. The conſtituent parts of this ſalt are,

Acid and water	47.12
Strontites	52.88
	100.00

20. Citrate of Strontites.

1. This combination of citric acid with ſtrontites may be formed by mixing together a ſolution of nitrate of ſtrontites and citrate of ammonia. A double decompoſition takes place, but no precipitate is formed. By ſlow evaporation, cryſtals of citrate of ſtrontites may be obtained.

2. This ſalt is ſoluble in water.

21. Malate of Strontites.

This ſalt is ſcarcely known.

22. Gallate of Strontites.

Little known alſo.

23. Benzoate of Strontites.

Unknown.

24. Succinate of Strontites.

Succinic acid combines with ſtrontites, and forms cryſtals, which may be obtained by ſlow evaporation.

25. Camphorate of Strontites.	Unknown.
26. Suberate of Strontites.	
27. Mellate of Strontites.	
28. Lactate of Strontites.	
29. Pruſſiate of Strontites.	
30. Sebate of Strontites.	

SECT. IV. *Of MAGNESIA and its Combinations.*

1332 Hiſtory. 1. Magneſia was firſt known about the beginning of the 18th century, when it was ſold by a Roman canon, under the name of *magneſia alba*, or *white magneſia*, and *the powder of the count of Palma*, as a cure for diſeaſes; and like many new remedies, it was conſidered as univerſal. In the year 1707, Valentini diſcovered that this boaſted *panacea* was the produce of the calcined ley which remains after the preparation of nitre. He gave it the pompous name of *the laxative powder of many virtues*. In the year 1709, Slevogt deſcribed the method of obtaining it by precipitation, from the mother ley of nitre. Lanciſi and Hoffman examined ſome of its properties in 1717 and 1722; and although the latter diſcovered that it formed different combinations with acids from thoſe of lime, it was generally confounded with this latter ſubſtance.

But the nature of magneſia was not fully known, till Dr Black, in 1755, entered upon his celebrated inveſtigations of the different properties of this ſubſtance, lime and the alkalies, in the mild and cauſtic ſtate. Margraaf publiſhed the reſult of his experiments and reſearches on it in 1759, in which he gave many diſtinctive characters of this earth, and of its combinations; and, at laſt, by the obſervations of Bergman, publiſhed in 1775, and thoſe of Butini of Geneva in 1779, the nature and properties of magneſia were fully demonſtrated.

1333 Preparation. 2. Magneſia, although it exiſts in great abundance in combination with other ſubſtances, has never been found perfectly pure in nature. The proceſs by which it may be obtained in greateſt purity, is the following. A quantity of Epſom ſalt, which is a compound of ſulphuric acid and magneſia, is to be diſſolved in water, and then precipitated by potaſh. The precipitate which is formed is to be well waſhed and dried, both with cold and hot water, to ſeparate any ſaline matters with which it may be mixed. The nature of this proceſs is obvious. The potaſh has a ſtronger affinity for ſulphuric acid than magneſia. It therefore combines with the acid, and the magneſia is precipitated.

1334 Properties. 3. Magneſia, when it is obtained pure, is in the form of a fine white powder, or in white friable cakes reſembling ſtarch. It has no ſmell, and no ſenſible taſte; but becomes dry, and leaves on the tongue a ſlight ſenſation of bitterneſs. Its ſpecific gravity, according to Kirwan, is 2.330. It gives a ſlight tinge of green to ſyrup of violets, or other delicate vegetable blues.

1335 Action of heat. 4. Magneſia is not acted upon by light. It is not melted when expoſed to the greateſt heat. By ſtrong calcination it becomes finer, whiter, and more friable. When it is expoſed to heat in the form of paſte with water, it contracts its dimenſions, and acquires a phoſphoreſcent property; for when it is ſtrongly rubbed on a hot iron plate, it becomes luminous in the dark. It is not altered by the action of the blow-pipe on charcoal, but gives out a flame of a ſlight yellow colour.

1336 Of air. 5. There is no action between magneſia and oxygen or azote. When expoſed to the air, it attracts a little moiſture from the atmoſphere, but this goes on very ſlowly.

Butini expoſed a quantity of magneſia for the ſpace of two years in a porcelain cup ſlightly covered with paper, and he found that it had acquired only $\frac{1}{143}$ part of its weight in addition, during that time.

6. There is no action between magneſia and hydrogen or carbone, and very little between it and phoſphorus.

1337 Of water. 7. Magneſia is very little ſoluble in water. According to Mr Kirwan, it requires near 8000 times its weight of cold water to diſſolve it. Butini found, that water boiled with this ſubſtance, and left in contact with it for three months, had ſcarcely acquired $\frac{1}{10000}$ part of its weight; but water combines with magneſia in the ſolid ſtate. One hundred parts of magneſia, according to Bergman, thrown into water, and taken out and dried, acquired 18 parts of additional weight.

1338 Affinities. 8. Magneſia enters into combination with the acids, and forms with them peculiar ſalts. The order of its affinities is the following, according to Bergman.

Oxalic acid,
Phoſphoric,
Sulphuric,
Fluoric,
Arſenic,
Saclactic,
Succinic,
Nitric,
Muriatic,
Tartaric,
Citric,
Lactic,
Benzoic,
Acetic,
Boracic,
Sulphurous,
Carbonic,
Pruſſic.

1339 Of earths. 9. Magneſia does not enter into combination with the fixed alkalies; but in combination with ſome of the earths, it becomes fuſible by means of a ſtrong heat. With lime in certain proportions, it forms a greeniſh yellow glaſs.

1340 Uſes. 10. Magneſia is much employed in medicine as a gentle laxative, and as an abſorbent to deſtroy the acidity in the ſtomach. It is uſed in pharmacy to ſuſpend or aid the ſolution of reſinous and gummy ſubſtances, ſuch as camphor and opium, in water, which are otherwiſe little ſoluble.

I. Of Sulphuret of Magneſia.

1341 Preparation. 1. Magneſia enters into combination with ſulphur, either in the dry or humid way. Two parts of magneſia and one of ſulphur, put into a crucible, and expoſed to heat, form an orange yellow maſs, which is not very ſoluble in water, but emits the odour of ſulphurated hydrogen gas, when it comes in contact with that liquid, and which is very readily decompoſed by means of heat. The heat that is applied to obtain this ſulphuret muſt be very moderate, otherwiſe the ſulphur is driven off.

2. The ſulphuret of magneſia is formed with more difficulty in the humid way. When two parts of magneſia and one of ſulphur in powder, with 20 parts of water, are expoſed to heat on a ſand bath, the liquid becomes of a pale yellow colour, which is ſlightly fetid, but has nothing of the ſtrong odour of the other ſulphurets. There is formed very little of the ſulphuret of magneſia; for the greateſt part of the ſulphur and magneſian earth remains uncombined. There is very little ſulphurated hydrogen produced, the water ſcarcely exhaling the odour of this gas.

1342 Properties. 3. The ſolid ſulphuret of magneſia decompoſes rapidly when expoſed to the air. It ſeems to abſorb very little ſulphurated hydrogen gas; ſo that the properties of the hydroſulphuret of magneſia are yet unknown *.

II. Compounds of Magneſia with Acids.

1. Sulphate of Magneſia.

1343 Hiſtory. The compound of ſulphuric acid and magneſia was formerly known under the name of *Epſom* and *Seidlitz ſalts*, becauſe it exiſts in the water of theſe ſprings, and *ſal catharticus amarus*, *bitter purging ſalt*, on account of its properties. It was long confounded with ſulphate of ſoda, till its properties were inveſtigated by Black, Macquer, and Bergman, and its nature and compoſition fully aſcertained.

1344 Preparation. 2. This ſalt exiſts abundantly in nature. It is found in many mineral ſprings, and it forms a conſiderable proportion of the ſaline ingredients of ſea water. The bittern or mother water of common ſalt, that is, the water which remains after the cryſtallization, conſiſts chiefly of ſulphate of magneſia. It is therefore rarely prepared by art, by the direct combination of its conſtituent parts. It is eaſily purified by diſſolving the ſalt in water, and by evaporation and cryſtallization.

1345 Properties. 3. The ſulphate of magneſia thus prepared, is cryſtallized in four-ſided priſms, terminated by four-ſided pyramids. There is, however, ſome deviation from this form. The primitive form of the cryſtal is a quadrangular priſm with ſquare baſes. The integrant molecule is a triangular priſm, whoſe baſes are right-angled iſoſceles triangles. It has a cool, bitter taſte. The ſpecific gravity is 1.66.

1346 Action of water and heat. 4. Expoſed to the air, it effloreſces. It is ſoluble in its own weight of cold water: boiling water diſſolves more than two-thirds of its weight. Expoſed to heat, it undergoes the watery fuſion, and being deprived of its water of cryſtallization, it does not melt, nor is it decompoſed by the ſtrongeſt heat. By the action of the blow-pipe it melts with difficulty into an opaque, vitreous globule.

1347 Of alkalies. 5. The ſulphate of magneſia is decompoſed by the fixed alkalies, but with ammonia it forms a triple ſalt.

1348 Compoſition. The component parts of this ſalt are, according to

		Kirwan.	
	Bergman.	In cryſtals.	Dry.
Sulphuric acid	33	29.35	63.32
Magneſia	19	17.00	36.68
Water	48	53.65	00.00
	100	100.00	100.00 *.

1349 Uſes. 6. The ſulphate of magneſia is employed in medicine as a purgative. From this ſalt, too, the earth of magneſia is uſually extracted.

2. Sulphate of Ammonia and Magneſia.

1350 Preparation. 1. This is a triple combination of ſulphuric acid with ammonia and magneſia. It is prepared by the partial decompoſition of the ſulphate of magneſia by means of ammonia. By evaporating the ſolution the triple ſalt is obtained in cryſtals.

1351 Properties. 2. This ſalt cryſtallizes in octahedrons. It has a bitter acrid taſte, does not effloreſce in the air, is leſs ſoluble in water than either of the ſalts of which it is compoſed, but it is more ſoluble in hot than in cold water, and it cryſtallizes on cooling. By heat it undergoes the watery fuſion. It then dries and is decompoſed. The component parts of this ſalt are,

Sulphate of magneſia,	64
of ammonia,	32
	100 †.

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* Fourcroy Connaiſs. Chim. ii. 160—167.

* Nichol. Jour. iii. p. 215.

† Fourcroy Connaiſs. Chim. iii. 49.

3. Sulphite of Magneſia.

1352 Preparation. 1. The compound of ſulphurous acid and magneſia is formed by paſſing ſulphurous acid gas into two parts of water, with one of carbonate of magneſia. A violent effervescence takes place, with the evolution of heat. The ſulphite of magneſia is formed, and precipitated to the bottom in the ſtate of powder; but with an exceſs of acid it is re-diſſolved, and cryſtallizes.

1353 Properties. 2. The cryſtals of ſulphite of magneſia are in the form of depreſſed tranſparent tetrahedrons. It has a mild earthy taſte, which ſoon becomes ſenſibly ſulphureous; it has no ſmell. Its ſpecific gravity is 1.3802.

1354 Action of air, &c. 3. It effloreſces in the air, and is ſlowly converted into ſulphate of magneſia. It is ſoluble in 20 parts of cold water. Boiling water diſſolves a greater proportion, and from this it cryſtallizes on cooling. Expoſed to heat, this ſalt becomes viſcid, and by calcination it loſes 0.45 of its weight. If the heat be increaſed, it is decompoſed; the acid is driven off, and the pure earth remains behind.

The component parts of this ſalt are,

Sulphurous acid	39
Magneſia	16
Water	45
	100

4. Sulphite of Ammonia and Magneſia.

1355 Preparation. 1. This triple ſalt is formed by decompoſing the ſulphite of ammonia by magneſia, or the ſulphite of magneſia by ammonia, in ſolution in the cold; or, by mixing together the ſolutions of the two ſalts.

1356 Properties. 2. This ſalt is in tranſparent cryſtals, the form of which has not been determined. When it is expoſed to the air, it is converted into ſulphate of ammonia and magneſia. It is leſs ſoluble in water than either of the two ſulphites of which it is formed. 1357 Action of heat. By the action of heat, ſulphurous acid is given out, acidulous ſulphite of ammonia is ſublimed, and there remains behind pure magneſia †.

5. Nitrate of Magneſia.

1358 Hiſtory and preparation. 1. This compound of nitric acid and magneſia was formerly called *nitre with baſe of magneſia*, and magneſian *ſalpetre*. It is formed by the direct combination of the acid with the earth. By evaporation it is cryſtallized.

1359 Properties. 2. This ſalt cryſtallizes in four-ſided rhomboidal priſms, whoſe ſummits are oblique or truncated. Sometimes it is in the form of ſmall needles combined in groups. The taſte is penetrating and bitter. The ſpecific gravity is 1.736.

1360 Action of heat. 3. It is deliqueſcent in the air, and is ſoluble in its own weight of cold water. It is more ſoluble in boiling water, in which it cryſtallizes on cooling; but it can only be obtained in regular cryſtals by ſlow evaporation from its ſolution in cold water.

1361 Of heat. 4. By the action of heat it undergoes the watery fuſion; the water is driven off, and it becomes dry. It is decompoſed in a ſtrong heat, gives out a little oxygen gas, then nitrous gas, and at laſt the nitric acid. The pure earth remains behind.

1362 Compoſition. The component parts of this ſalt are, according to

	Bergman.	Kirwan.
Acid	43	46
Magneſia	27	22
Water	30	32
	100	100

6. Nitrate of Ammonia and Magneſia.

1363 Preparation. 1. This triple ſalt is formed, either by the direct combination of the ſolutions of nitrate of ammonia, and nitrate of magneſia, by which the ſalt is obtained pure and cryſtallized; or, by partially decompoſing the nitrate of ammonia by magneſia, or the nitrate of magneſia by ammonia.

1364 Properties. 2. The cryſtals of this ſalt are in the form of fine priſms. It has a bitter, acrid, and ammoniacal taſte. It is leſs deliqueſcent in the air than either of the conſtituent ſalts, and leſs ſoluble in water. It requires 11 parts of cold water to diſſolve it, but leſs of boiling water. It cryſtallizes on cooling.

1365 Action of heat. When it is rapidly heated, it inflames ſpontaneouſly. When ſlowly heated in cloſe veſſels, it gives out oxygen gas, azotic gas, a greater proportion of water than it contains, nitrous gas, and nitric acid, without the ſmalleſt trace of ammonia; which ſhows that it is decompoſed, that the hydrogen combines with the oxygen of the acid, and forms water.

1366 Compoſition. The component parts of this ſalt are,

Nitrate of magneſia	78
——— ammonia	22
	100 *

7. Nitrite of Magneſia.

Nothing is known of the properties of this ſalt.

8. Muriate of Magneſia.

1367 Found native. 1. This componud of muriatic acid and magneſia was formerly called *marine ſalt of magneſia*, and was confounded with the muriate of lime, with which it is frequently accompanied. The difference between theſe two ſalts was firſt pointed out by Dr Black, and Bergman afterwards examined the nature and properties of muriate of magneſia. The ſalt is obtained by diſſolving magneſia in muriatic acid till they are ſaturated, and then evaporating the ſolution. Small irregular cryſtals are obtained. This ſalt exiſts in the waters of the ocean, and in mineral waters, along with the muriates of ſoda and lime.

1368 Properties. 2. It is extremely difficult to obtain the muriate of magneſia in any regular form. It is either in the ſtate of powder, or very ſmall regular needles, or in a kind of jelly. It has a diſagreeable bitter taſte. The ſpecific gravity is 1.601.

3. It is very deliqueſcent in the air. Cold water readily diſſolves its own weight, and it is ſtill more ſoluble in boiling water.

1369 Action of heat. 4. It is completely decompoſed by heat; the acid is driven off, and the pure earth remains behind *.

1370 Compoſition.

	Bergman.	Kirwan.
Acid	34	34.59
Magneſia	41	31.07
Water	25	34.38
	100	100.04 †

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† *Ibid.* p. 89.

* *Fourcroy Connaiſs. Chim.* iii. 144.

* *Fourcroy*, iii. 224.

† *Nicholſon's Journ.* iii. 215.

9. Muriate of Ammonia and Magneſia.

1371 Preparation. This triple ſalt is formed by mixing the ſolutions of muriate of magneſia and muriate of ammonia; and by evaporating the ſolution the ſalt cryſtallizes in the form of ſmall polyhedrons. 1372 Properties. It has a bitter, ammoniacal taſte. It is little altered by expoſure to the air, and is ſoluble in ſix parts of cold water. It is decompoſed by heat. The muriate of ammonia is ſublimed, and the muriate of magneſia is deprived of its acid.

1373 Compoſition. The component parts of this ſalt are,

Muriate of magneſia,	73
——— ammonia,	27
	100

10. Hyperoxymuriate of Magneſia.

This is ſimilar in its chemical and phyſical properties to the hyperoxymuriate of lime, and it is prepared in the ſame way. It is precipitated by lime and ammonia.

1374 Compoſition. The component parts are,

Acid,	60.
Magneſia,	25.7
Water,	14.3
	100.0 *

11. Fluate of Magneſia.

1375 Preparation. 1. This ſalt is formed by combining together fluoric acid and magneſia. According to Scheele, it precipitates in the form of a gelatinous maſs; but Bergman obſerves that great part of the ſalt is depoſited as the 1376 Properties. ſaturation approaches. By evaporating the ſolution, cryſtals in the form of ſix-ſided priſms, terminated by a low pyramid compoſed of three rhomboidal ſides, are obtained.

2. This ſalt is not decompoſed by the ſtrongeſt heat, or by any acid.

12. Fluate of Ammonia and Magneſia.

This triple ſalt is formed by mixing the ſolutions of the fluates of ammonia and magneſia. A precipitation is formed, which is the triple ſalt in cryſtals. The properties of this ſalt are unknown †.

13. Borate of Magneſia.

1377 Preparation. 1. This ſalt is formed by the direct combination of boracic acid with magneſia. The earth is ſlowly diſſolved, and when the ſolution is evaporated, cryſtals are obtained.

1378 Properties. 2. The cryſtals of this ſalt are very ſmall and irregular. It melts when expoſed to heat, without being decompoſed; but it may be decompoſed, it is ſaid, by alcohol ‡.

14. Borate of Magneſia and Lime.

1379 Found native. 1. This ſalt, which has been lately diſcovered native, is called by mineralogiſts *cubic quartz*. It was analyzed by Weſtrumb in 1788. It is an inſipid ſalt, and is regularly cryſtallized in polyhedrons of 22 faces. The ſpecific gravity is 2.566.

1380 Properties. 2. It is not altered by expoſure to the air, nor is it ſoluble even in boiling water. Expoſed to a ſtrong red heat, the cryſtals loſe their luſtre; and with a white heat they decrepitate, and at laſt melt into a yellow coloured glaſs.

1381 Compoſition. 3. The component parts of this ſalt are,

Acid,	73.5
Magneſia,	14.6
Lime,	11.9
	100.0

15. Phoſphate of Magneſia.

1382 Preparation. 1. This ſalt may be obtained by the direct combination of phoſphoric acid and carbonate of magneſia; for, it may be prepared by mixing together phoſphate of ſoda and ſulphate of magneſia in ſolution. In a few hours, large, tranſparent cryſtals are formed in the ſolution.

1383 Properties. 2. This ſalt cryſtallizes in ſix-ſided priſms with unequal ſides, but it is frequently in the form of powder. It has a cooling, ſweetiſh taſte. The ſpecific gravity is 1.5489.

1384 Action of water. 3. It effloreſces in the air, is not very ſoluble in cold water, and requires about 50 parts of boiling water for its ſolution, and part of it cryſtallizes on cooling. 1385 Of heat. When it is heated, it is eaſily deprived of its water of cryſtallization, and if the heat be moderate, it melts and falls down into a white powder. With a ſtronger heat, it is melted into glaſs.

16. Phoſphate of Ammonia and Magneſia.

1386 Found native. 1. This triple ſalt was diſcovered by Fourcroy in a calculous concretion, found in the colon of a horſe. The reſults of his experiments on this ſubſtance have been confirmed by Berthollet and Vauquelin.

1387 Preparation. 2. It may be prepared artificially, by mixing together a ſolution of phoſphate of magneſia with a ſolution of phoſphate of ammonia.

1388 Properties. 3. The cryſtals are in the priſmatic form, but cannot be accurately aſcertained. This ſalt has no taſte. In the concrete form, it is found in the cavities of animal bodies, and ſometimes it is cryſtallized, but moſt frequently lamellated and ſemitranſparent.

1389 Action of heat. 4. It is not changed by the action of the air, and is ſcarcely ſoluble in water. When it is heated moderately, it falls to powder. With a ſtronger heat it is deprived of the ammonia, and under the blow-pipe it melts into a tranſparent globule. It is decompoſed by the ſulphuric, nitric, and muriatic acids.

1390 Compoſition. The component parts of this ſalt found in the inteſtine of the horſe are,

Phoſphate of ammonia	33.3
——— magneſia	33.3
——— water	33.3
	100.0

17. Phoſphite of Magneſia.

1391 Preparation. 1. This ſalt may be prepared by directly combining phoſphorous acid with magneſia. Or it may be obtained in a purer ſtate, and cryſtallized, by mixing together ſolutions of phoſphites of ſoda or of potaſh, and ſulphate of magneſia, by which means it is obtained in brilliant milky flakes.

2. This

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* *Phil. Tranſ.* 1802, p. 149.

† *Fourcroy*, iii. 308.

‡ *Ibid.* 319.

1392 Properties. 2. This ſalt, which has no ſenſible taſte, ſometimes cryſtallizes in the form of tetrahedrons. It effloreſces in the air, and is ſoluble in 400 parts of cold water. When expoſed to heat, it ſuddenly ſwells up, and melts into a glaſs. Under the blow-pipe it gives out a phoſphoric light, and becomes opaque on cooling.

The component parts of this ſalt are,

Acid	44
Magneſia	20
Water	36
	100

18. Phoſphite of Ammonia and Magneſia.

This ſalt is formed by the partial decompoſition of phoſphite of ammonia by means of magneſia, or by mixing together the ſolutions of the two phoſphites. If the ſolutions be ſufficiently concentrated, the triple phoſphite is readily depoſited. It forms cryſtals, and has little ſolubility in water. Its other properties are unknown.

19. Carbonate of Magneſia.

1393 Names and preparation. 1. This ſalt, which was firſt diſtinguiſhed by Dr Black, has been called *mild magneſia*, *aërated magneſia*. It is formed by mixing together ſulphate of magneſia and carbonate of potaſh in ſolution. Or it may be obtained by diſſolving pure magneſia in water ſaturated with carbonic acid. The ſalt, as the ſolution is evaporated, cryſtallizes.

1394 Properties. 2. The magneſia of commerce, which is in the ſtate of powder, or light friable cakes, is not fully ſaturated with the acid. But when it is cryſtallized by the above proceſſes, it is in the form of tranſparent ſix-ſided priſms, terminated by a hexagonal plane. This ſalt has little taſte. The ſpecific gravity is 0.2941.

1395 Action of water and heat. 3. When it is cryſtallized, it ſoon loſes its tranſparency in the air. It is ſoluble in 48 parts of cold water. Expoſed to heat in a crucible, it ſlightly decrepitates, is deprived of its water and acid, and falls down into a powder. It is decompoſed by all the acids. The component parts of this ſalt are, according to

1396 Compoſition.

	Bergman.	Butini.	Fourcroy.
Acid	30	36	50
Magneſia	45	43	25
Water	25	21	25
	100	100	100

The magneſia of commerce is compoſed of

	Fourcroy.	Kirwan.
Carbonic acid	48	34
Magneſia	40	45
Water	12	21
	100	100

20. Carbonate of Ammonia and Magneſia.

This triple ſalt is prepared by decompoſing carbonate of ammonia by means of magneſia; or by precipitating a ſolution of carbonate of magneſia by means of pure ammonia. This ſalt, however, has not been particularly examined.

21. Arſeniate of Magneſia.

When arſenic acid is ſaturated with magneſia, a thick matter forms towards the point of ſaturation, which is ſoluble in exceſs of acid; but when it is evaporated, it does not cryſtallize. It aſſumes the form of a jelly. It is decompoſed by the alkaline arſeniates.

22. Tungſtate of Magneſia.

This acid, in combination with magneſia, forms a ſalt which appears in the form of brilliant ſcales. It is not altered by expoſure to the air, and it is ſoluble in water. It is decompoſed by acids, and a white powder is precipitated.

23. Molybdate of Magneſia.	Unknown.
24. Chromate of Magneſia.	
25. Columbate of Magneſia.	

26. Acetate of Magneſia.

This ſalt is formed by the direct combination of magneſia with acetic acid. It does not cryſtallize, but a viſcid maſs remains when the ſolution is evaporated. It has a ſweetiſh taſte, leaving afterwards an impreſſion of bitterneſs. The ſpecific gravity is 1.378. It deliqueſces in the air, is very ſoluble in water, and is decompoſed by heat.

27. Oxalate of Magneſia.

This ſalt is formed by combining oxalic acid with magneſia, and evaporating the ſolution. A ſalt is obtained in the form of white powder, which is ſcarcely ſoluble in water. It is decompoſed by heat. The component parts of this ſalt are,

Acid and water	65
Magneſia	35
	100

28. Tartrate of Magneſia.

This compound of tartaric acid and magneſia forms a ſalt which is inſoluble in water, without an exceſs of acid. When this is the caſe, it cryſtallizes by evaporation. The cryſtals are in the form of hexangular truncated priſms. It is firſt melted, and then decompoſed by heat.

29. Citrate of Magneſia.

This ſalt is obtained by diſſolving carbonate of magneſia in citric acid. From the thick ſolution of this ſalt, there is no cryſtallization; but after ſome days, by a ſlight agitation, it aſſumes the form of a white opaque maſs, which remains ſoft, as it ſeparates from the edges of the veſſel. The component parts of this ſalt are,

Acid	66.66
Magneſia	33.34
	100.00 *

30. Malate of Magneſia.

This is a deliqueſcent ſalt, and very ſoluble in water.

31. Gallate

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* Fourcroy vii. 208.

31. Gallate of Magneſia.

Magneſia boiled with an infuſion of nut galls, affords a clear liquid, which aſſumes a green colour. By evaporation to dryneſs the green colour vaniſhes, and the acid is decompoſed.

32. Benzoate of Magneſia.

The combination of benzoic acid with magneſia affords plumoſe cryſtals which are eaſily ſoluble in water. This ſalt has a bitter taſte.

33. Succinate of Magneſia.

The ſalt which is formed by the combination of ſuccinic acid and magneſia, does not cryſtallize. It is a white glutinous maſs which is deliqueſcent in the air.

34. Saccolate of Magneſia.

This ſalt is inſoluble in water.

35. Camphorate of Magneſia.

1397 Preparation. 1. This ſalt is formed by mixing carbonate of magneſia with water, and adding cryſtallized camphoric acid. A ſlight efferveſcence takes place. The temperature ſhould be increaſed, to drive off the carbonic acid. The ſolution is filtered while it is hot, and evaporated to dryneſs. The maſs is diſſolved in diſtilled water, filtrated and evaporated by a gentle heat, till a pellicle appears on the ſurface. By cooling there are depoſited ſmall plates, which are heaped upon each other.

1398 Properties 2. This ſalt, which does not cryſtallize, is white and opaque, and has a bitter taſte. In the air it is ſlightly effloreſcent. It is not very ſoluble in water. Boiling water diſſolves a little, but it is precipitated in cooling. When it is thrown on red-hot coals, the acid is volatilized, and pure magneſia remains behind. By the action of the blow-pipe it gives out a bluiſh flame. It is decompoſed by ſulphuric, nitric, and muriatic acids *.

36. Suberate of Magneſia.

The compound of ſuberic acid and magneſia is in the form of powder. It has a bitter taſte, is deliqueſcent in the air, and ſoluble in water. It reddens the tincture of turnſole. Expoſed to heat, it ſwells up and melts. By the action of the blow-pipe, the ſalt is decompoſed, the acid is driven off, and pure magneſia remains behind. The ſulphuric, nitric, and muriatic acids, decompoſe it. It is alſo decompoſed by the alkalies, barytes, and lime †.

37. Mellate of Magneſia.

Unknown.

38. Lactate of Magneſia.

A ſalt in ſmall deliqueſcent cryſtals.

39. Pruſſiate of Magneſia.

This ſalt may be prepared by directly combining pruſſic acid with pure magneſia; but the magneſia is precipitated when the ſolution is expoſed to the air. It is alſo decompoſed by the alkalies and lime.

Sect. V. *Of Alumina and its Combinations.*

1399 Hiſtory. 1. *Alumina*, which is now employed to ſignify one of the ſimple earths, is derived from the word *alum*, of which this earth forms a conſtituent part, and from which it is obtained in greateſt purity. It was formerly denominated *argil* and *argillaceous earth*; but theſe names, being expreſſive of mixtures of different earths, have been properly rejected. Pott and Margraaf were the firſt who diſtinguiſhed this earth from the calcareous earth or lime, and proved that this latter earth could not be obtained from it by calcination. In the year 1739, Hellot ſhewed, that the baſis of alum, ſeparated from this ſalt by an alkali, was pure argil, or alumina. In 1758 and 1762 Macquer examined this earth, and detailed its characteriſtic properties. Theſe were afterwards farther elucidated and confirmed by the experiments and reſearches of Bergman and Scheele, ſo that the nature and characters of this earth were completely developed, and it was univerſally admitted as diſtinct from all others hitherto known.

1400 Preparation. 2. Although alumina exiſts in great abundance in nature, yet it is rarely found uncombined, or in a ſtate of perfect purity. It may be obtained pure by the following proceſs.

Diſſolve a quantity of common alum in water, and add to the ſolution, a ſolution of potaſh or carbonate of potaſh, or, what is ſuppoſed to be ſtill better, liquid ammonia. An abundant white precipitate is immediately formed. Continue the addition of the alkali as long as any precipitate appears. When the whole of the precipitate has collected at the bottom of the veſſel, pour off the fluid part, and waſh the precipitate repeatedly with large quantities of water, to free it from all ſaline matters which it may have retained. Dry the precipitate in a moderate heat, and the ſubſtance thus obtained is alumina in a ſtate of tolerable purity. If this precipitate retain any portion of ſulphuric acid, it may be ſeparated by adding muriatic acid in ſmall quantities at a time, till the whole is diſſolved. Evaporate the ſolution till a drop of it, when ſuffered to cool on a plate of glaſs, yields minute cryſtals. Then ſet by the ſolution till it cool, and cryſtals will be depoſited. Let theſe cryſtals be removed by pouring off the fluid, and continue the evaporation till no more cryſtals are formed. In this way the alum which the earth retained, may be ſeparated. The liquid which remains is to be mixed with ammonia as long as any precipitate appears. This precipitate, well waſhed and dried, is pure alumina.

1401 Properties. 3. The alumina obtained by this proceſs, is either in the form of friable fragments, or of very fine white powder, ſoft to the touch, and inſipid to the taſte. It has a peculiar odour, which is diſtinguiſhed by the name of *earthy ſmell*, and is only perceptible when it is breathed upon, or moiſtened (o). It adheres to the tongue in

* *Ann. de Chim.* xxvii. p. 37.

† *Ibid.* xxiii. p. 56.

(o) This ſmell, however, as it has been juſtly obſerved by Sauſſure, is owing to the oxide of iron, with which the alumina, in its ordinary ſtate of purification, is contaminated; for when it is perfectly pure, and no conſequence of its rapidly abſorbing moiſture. The ſpecific gravity is 2.

1402 Spongy alumina.

4. Sauſſure has obſerved, that alumina exhibits two different appearances, according to the quantity of water which has been employed in the ſolution of the aluminous ſalt. If the quantity of water does not exceed what is neceſſary for the ſolution of the ſalt, we obtain a light friable white earth, which is very ſpongy, and adheres to the tongue. This he calls *ſpongy alumina*. But when the ſalt is diſſolved in a large quantity of water, we obtain, after drying the precipitate in the ſame temperature, a yellowiſh brittle tranſparent maſs, which ſplits into ſmall fragments, when held in the hand, like ſolid ſulphur. It has a ſmooth conchoidal fracture, no earthy appearance, does not adhere to the tongue, and does not ſwell up when put into water. It occupies 10 or 12 times leſs volume than in the ſpongy ſtate, and has ſome reſemblance to gum arabic, or a dried jelly. This he diſtinguiſhes by the name *gelatinous alumina* *.

1403 Gelatinous.

1404 Action of heat.

5. Alumina undergoes no change by being expoſed to light. When it is expoſed to heat, it is diminiſhed in bulk, in conſequence of being deprived of the water with which it is combined. Accordingly, Sauſſure has obſerved, that the ſpongy alumina expoſed to the ſame temperature, loſes a greater quantity of moiſture than the gelatinous alumina. The former, when expoſed to a red heat, loſes 0.58 part of its weight; but the latter only 0.43 part. When they are both expoſed to a very ſtrong heat, the ſpongy alumina is deprived of no more water than what it gives out with a red heat, while the gelatinous parts with only 0.4825. On this property of the contraction of bulk of alumina when expoſed to heat, depends the principle of the thermometer, or pyrometer, of Wedgwood, of which we ſhall immediately give a ſhort deſcription.

When alumina is expoſed to a very ſtrong heat ſuddenly applied, as by means of the blow-pipe, with a ſtream of oxygen gas, it is ſuſceptible of a kind of fuſion; and when it is cooled, it appears under the form of an enamel, of a greeniſh colour, and ſo hard, as to cut glaſs.

1405 Of water.

6. Alumina is not ſoluble in water, but it abſorbs and retains that fluid in conſiderable quantity. With a greater quantity of water it is diffuſed in it, and may be formed into a paſte, in which ſtate it is moulded with great facility into any form.

7. There is no action between alumina and oxygen, azote, hydrogen, or phoſphorus; and very little between it and ſulphur, except when they are in a ſtate of minute diviſion, or in combination with ſome other ſubſtances. Carbone combines with alumina, of which there are many natural compounds, among the claſs of bituminous foſſils; but even in theſe compounds, the carbone and alumina are mixed with other earths, and with the oxide of iron.

1406 Of carbone.

1407 Of acids.

8. Alumina enters into combination with almoſt all the acids, and forms ſalts which are more or leſs ſoluble, and ſuſceptible of cryſtallization. Some are inſoluble in water, and others require an exceſs of acid.

1408 Affinities.

9. The order of its affinity for the acids, is the following.

Sulphuric acid,
Nitric,
Muriatic,
Oxalic,
Arſenic,
Fluoric,
Tartaric,
Succinic,
Saclactic,
Citric,
Phoſphoric,
Lactic,
Benzoic,
Acetic,
Boracic,
Sulphurous,
Carbonic,
Pruſſic.

1409 Of alkalies.

10. Alumina combines with the fixed alkalies. When they are heated together, an opaque maſs, which has little coherence, is formed. Fixed alkali diſſolved in water, with the aſſiſtance of heat, has the property of diſſolving alumina; but from this ſolution it may be precipitated by means of an acid, and then it is obtained in great purity. Liquid ammonia alſo holds a ſmall quantity of alumina in ſolution, if it has been recently precipitated.

1410 Of earths.

11. Alumina enters into combination with many of the earths, and particularly with lime and ſilica. Theſe compounds form the chief baſis of all kinds of pottery and porcelain. Alumina combines with lime, and enters into fuſion with it by means of heat. A compound is alſo formed with alumina and barytes, or ſtrontites, by expoſing them together in a crucible to a ſtrong heat; or, by boiling them together in water. Magneſia and alumina alone, do not enter into combination by means of the ſtrongeſt heat; but a porcelain is obtained from a mixture of lime, magneſia, and alumina. But in the proportions that are employed, it is neceſſary that the alumina be greateſt. The following table ſhews the reſults of experiments on theſe earths in different proportions *.

Alumina,	3	A porcelain.
Lime,	2	
Magneſia,	1	
Alumina,	3	A porcelain.
Magneſia,	2	
Lime,	1	
Alumina,	3	Porous porcelain.
Magneſia,	3	
Lime,	1	
Alumina,	3	Porous porcelain.
Magneſia,	3	
Lime,	2	

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traces of oxide of iron can be detected, it has no perceptible ſmell. To alumina which was perfectly inodorous, he communicated this ſmell, by triturating it with oxide of iron. *Journal de Phyſique*, lii. p. 287.

* *Jour. de Phyſique*, lii. p. 290.

* *Kirwan, Mineral.* i. p. 61.

Alumina,	3	Porcelain.
Lime,	2	
Magneſia,	2	

1411 Uſes. 12. This is one of the moſt important of the earths, on account of the variety of purpoſes to which it is applied. It forms the baſes of all kinds of earthen ware, from the coarſeſt brick to the fineſt china. It is alſo chiefly employed in the pots or crucibles which are expoſed to very ſtrong heat, as in glaſs manufacture and caſt iron. It is employed alſo in dyeing and calico-printing, and in the cleaning or ſcouring of woollen ſtuffs. It has been applied to a valuable uſe by the late Mr Wedgwood, in the conſtruction of an inſtrument capable of aſcertaining high degrees of temperature, to which the common thermometer cannot reach.

1412 Wedgwood's pyrometer. 13. This inſtrument is conſtructed on the principle of the contraction of pure clay, when it is expoſed to heat. Mr Wedgwood took a very pure clay, and formed it into ſmall ſhort cylinders, which were made exactly of the ſame ſize. They are then baked in a low red heat, to expel the whole of the air and moiſture which adhere to the clay. The cylinders are thus prepared for the meaſurement of ſtrong heats. For this purpoſe, one of the cylinders is introduced between two rulers, to which a ſcale is attached, and its bulk is exactly meaſured. It is then introduced into the furnace whoſe heat is to be tried, and the temperature is to be eſtimated according to the diminution of bulk which the cylinder has ſuſtained. The quantity of contraction is meaſured by means of two metallic rulers, which are fixed upon a plate. Theſe rulers are 24 inches in length, and are divided into 240 parts. The diſtance between the rulers at the upper extremity of the ſcale is 0.5 of an inch, and at the lower extremity 0.3 of an inch. The ſize of the clay cylinder, before it is introduced into the furnace, nearly fits the upper part of the ſcale; or at leaſt the degree at which it ſtands, before it is introduced into the furnace, is marked. After being heated, the clay cylinder is again applied to the ſcale, and the diminution of bulk is meaſured by the diſtance at which it ſtands between the rulers from the top of the ſcale, or from the degree at which it ſtood before it was expoſed to the heat.

1413 Scale of it. Mr Wedgwood connected the ſcale of his pyrometer with Fahrenheit's thermometer. The firſt degree of his ſcale which marks a red heat, correſponds to the 947° Fahrenheit; but to make this inſtrument better underſtood, we may ſtate a few of the correſponding degrees of the two inſtruments.

	Wedgwood.	Fahrenheit.
Red heat,	0 =	947
Fine ſilver melts	28	4717
Fine gold melts	32	5237
Welding heat of iron	95	13427
Caſt iron melts	130	17977
Greateſt heat in an air furnace eight inches ſquare	160	21877
Extremity of the ſcale, or higheſt temperature obſerved	240	32277

This inſtrument has been of conſiderable importance in ſome arts and manufactures, and it is undoubtedly fitted to give ſome information concerning thoſe intenſe heats which can be meaſured by no other inſtrument which has yet been contrived. But as the ſame kind of clay cannot always be obtained, and as it is probable that the contractions of the cylinders are not proportional to the temperatures, their eſtimation by this inſtrument can only be conſidered as an approximation to certainty.

I. Compounds of Alumina with Acids.

1. Sulphate of Alumina.

1414 Preparation. 1. This is a compound of ſulphuric acid and alumina. It may be formed by the direct combination of the acid with the earth. But in the preparation of this ſalt, the earth and the acid muſt be in a ſtate of purity, and muſt be ſaturated with each other. The ſolution is then evaporated to dryneſs; the ſalt is again diſſolved in diſtilled water, and evaporated ſlowly till it cryſtallizes.

1415 Properties. 2. The cryſtals of this ſalt are in the form of thin plates, ſoft and pliant, with a brilliant pearly luſtre, and of an aſtringent taſte. It is not altered by expoſure to the air; it is very ſoluble in water, but it does not cryſtallize readily. When it is heated, it is infuſible; but by long calcination, it dries and falls down to powder. At a high temperature it is decompoſed, and the acid is driven off.

1416 Action of heat, &c.

3. The ſulphuric acid readily combines with this ſalt, and forms with it an acidulous ſulphate of alumina. This ſalt has a more acid taſte than the former; it cryſtallizes with more difficulty, and the cryſtals have more brilliancy. It reddens vegetable blues, and frequently aſſumes the form of a thick gelatinous maſs.

4. All the alkaline and earthy baſes, except ſilica and zirconia, decompoſe either of theſe two ſalts. The ſaturated ſulphate of alumina, according to Bergman, is compoſed of

1417 Compoſition.

Sulphuric acid,	50
Alumina,	50
	100

2. Acidulous Sulphate of Alumina and Potaſh, or Alum.

1418 Hiſtory. 1. The alum of commerce, now of ſuch extenſive utility in many of the arts and manufactures, was imported into Europe from Aſia, previous to the 15th century, during which it was begun to be manufactured in Italy. Alum works were erected in Spain and Germany in the 16th century; and towards the end of it, a manufactory of this ſalt was eſtabliſhed in Yorkſhire in England. But the true nature of alum has been only of late underſtood. It is to the experiments and reſearches of Vauquelin, that we are indebted for the knowledge of its component parts.

1419 Preparation. 2. Alum is generally obtained by expoſing to the weather for ſome time, aluminous ſchiſtus, or what are called *aluminous ores*, which are natural productions, ſometimes found in the neighbourhood of volcanoes, and ſometimes, as in Britain, dug out of coal mines which abound with pyrites or ſulphuret of iron. When theſe ſubſtances, which are alſo mixed with a conſiderable proportion of clay, are expoſed to air and moiſture, the ſulphur combines with the oxygen of the air, or with that of the water, by decompoſing it, and is thus converted into ſulphuric acid. This combines with the alumina, and thus there is formed a ſulphate of alumina. The ſalt thus formed, is diſſolved in water, and muſt be purified by repeated boilings and cryſtallizations. This aluminous ſchiſtus is generally mixed with a conſiderable proportion of ſulphate of iron. From this it is to be ſeparated during the proceſs, and the potaſh or ammonia which is neceſſary to conſtitute the triple ſalt, muſt be added. Even before the component parts of alum were diſcovered, the addition of potaſh or ammonia was found to be neceſſary to complete the proceſs. This was well known to the manufacturers, who ſuppoſed that it was neceſſary to take up a quantity of acid, which being in exceſs, prevented the granulation, as it was called, or the cryſtallization of the alum.

1420 Properties. 3. Alum cryſtallizes in regular octahedrons; but this form is ſubject to conſiderable variety, according to the difference of proportion which is found to take place among its component parts. The primitive form of the cryſtal is the regular octahedron, and the integrant molecule the regular tetrahedron. It has a very aſtringent, ſtyptic, and ſomewhat ſweetiſh taſte. It uſually reddens vegetable blues. The ſpecific gravity is 1.7109.

1421 Action of water and heat. 4. It is little changed by expoſure to the air. By long contact there is a ſlight eﬄoreſcence on the ſurface. Alum is ſoluble in 16 or 20 parts of cold water. Boiling water diſſolves a greater proportion. When expoſed to heat, it melts in its water of cryſtallization. It then ſwells up, enlarges in volume, and there remains behind a light, porous, dry maſs, which has a ſharp acid taſte, and reddens more ſtrongly vegetable blues. In this ſtate it is called *burnt* or *calcined alum.* When it is expoſed to a ſtronger heat, the acid is driven off.

1422 Varieties. 5. According to the experiments of Vauquelin, there are three kinds or varieties of alum, which, although they poſſeſs nearly the ſame properties, have different conſtituent parts, or different proportions of the ſame conſtituents. The firſt is ſulphate of alumina and potaſh with an exceſs of acid; which indeed is neceſſary to conſtitute alum. The ſecond conſiſts of alumina and ammonia, alſo with an exceſs of acid. The third variety, which is moſt frequently found among the alum of commerce, is a mixture of both. It contains both potaſh and ammonia. When an additional quantity of potaſh is added, the alum cryſtallizes, not in its uſual form, but in the form of cubes, and hence it has been denominated *cubic alum.* If a ſtill greater quantity of potaſh be added, the cryſtallization is nearly interrupted; and it then appears in the form of flakes.

1423 Compoſition. The component parts of alum, are according to

Vauquelin.		Kirwan.	
Sulphate of alumina,	49	Acid,	17.66
——— potaſh,	7	Baſe,	12.00
Water,	44	Water,	70.34
	100		100.00

1424 Action of charcoal. 6. The three varieties of alum are nearly decompoſed in the ſame way, by combuſtible ſubſtances. If alum be expoſed to a moderate heat with charcoal, it is converted into the ſtate of neutral ſalt, becauſe the charcoal acts on the exceſs of acid, before it can effect the decompoſition of the ſalt; but when it is ſtrongly heated, there is formed with the ſulphate of alumina and potaſh, a black ſubſtance, which ſpontaneouſly takes fire in the air. This ſubſtance has been diſtinguiſhed by the name of *pyrophorus;* and it is called *Homberg's pyrophorus*, becauſe it was diſcovered by that chemiſt.

1425 Pyrophorus. Pyrophorus is prepared by mixing together three parts of alum, and one of flour or ſugar, in an iron ladle, and expoſing the mixture to heat till it ceaſes to ſwell, and becomes black. It is then to be reduced to powder, put into a glaſs phial, and again expoſed to heat, till a blue flame proceeds from the mouth of the phial. After it burns for a minute, it is allowed to cool, and muſt be kept in a well-cloſed bottle.

1426 Properties. 7. The pyrophorus thus formed, contains a hydrogenated ſulphuret of potaſh and alumina, mixed with charcoal in a ſtate of minute diviſion. It kindles more readily in humid than in dry air. The oxygen gas of the atmoſpheric air is abſorbed. Part is converted into carbonic acid, and part combines with the ſulphur, and forms ſulphuric acid; ſo that when the pyrophorus is burnt, it no longer contains the hydrogenated ſulphuret as before, but ſulphate of alumina and potaſh; not in the ſtate of alum, becauſe it has been deprived of the exceſs of acid, which gives alum its peculiar character.

8. Pyrophorus gives out a very fetid odour, when it is thrown into water, and leaves behind a ſulphuret of potaſh, and of hydrogenated alumina. It is inflamed by nitrous gas, and by oxymuriatic acid gas *.

1427 Uſes of alum. 9. The uſes of alum are very numerous. It is employed in medicine as an aſtringent and ſtyptic. It is alſo employed in the arts of bleaching, of tanning, dyeing, calico-printing, and others. It is ſometimes uſed in preſerving animal matters from putrefaction, and it might be employed for the purpoſe of ſecuring wood from catching fire.

1428 Preparation. *Sulphate of alumina and potaſh.*—1. If a ſolution of cryſtallized alum be boiled with a ſolution of pure alumina, the ſaturated ſulphate of alumina and potaſh is formed. The exceſs of acid, it is obvious, in this proceſs, enters into combination with the alumina. The alum, as the earth is added, is gradually precipitated in the ſolution, in the form of a white powder.

1429 Properties. 2. This ſalt, ſaturated with alumina, never aſſumes any regular form. It has no taſte, is not changed by expoſure to the air, is not ſoluble in water, and when it is expoſed to heat, it is not altered, except at a very high temperature. This ſalt is leſs eaſily decompoſed than any of the other varieties of ſulphate of alumina. By the action of ſome of the acids it is converted into alum, which is owing to the acid combining with the additional portion of alumina, that ſaturated the exceſs of acid exiſting in the alum. This ſalt has been applied to no uſe.

3. Sulphite of Alumina.

1430 Preparation. 1. The compound of ſulphurous acid and alumina is prepared by paſſing ſulphurous acid gas into water in which pure alumina is mixed or ſuſpended.

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* Fourcroy, iii. p. 59.

1431 Properties. 2. The ſulphite of alumina thus formed, is in the ſtate of a white, ſoft powder, which has at firſt an earthy taſte, and becomes afterwards ſulphureous. When it is expoſed to the air, for a long time, it is converted into the ſulphate of alumina, and more rapidly if it be combined with an exceſs of ſulphurous acid. It is inſoluble in water. Expoſed to heat, the acid is driven off, and partially decompoſed, for there remains behind a ſmall quantity of ſulphur. The component parts of this ſalt, are

1432 Compoſition.

Sulphurous acid	32
Alumina	44
Water	24
	100

4. Nitrate of Alumina.

1433 Preparation. 1. The ſalt was formerly known under the names of *nitre of argil*, and *nitrous alum*. It is formed by the direct combination of the nitric acid with alumina. It has been found impoſſible to neutralize the acid; and it cannot be obtained cryſtallized, excepting in the form of thin plates, and often only in a gelatinous maſs.

1434 Properties. 2. This ſalt has an auſtere and acid taſte. The ſpecific gravity is 1.645. It is deliqueſcent in the air, and extremely ſoluble in water. When it is heated, the acid is driven off, and the pure earth remains behind. It is readily decompoſed by the ſulphuric acid, which diſengages the nitric acid; and by the muriatic acid, which is converted into the oxymuriatic acid.

5. Nitrite of Alumina.

This ſalt is unknown.

6. Muriate of Alumina.

1435 Purification. 1. This ſalt, which is a compound of muriatic acid and alumina, is formed by the direct combination of the acid with the earth; but it is never neutralized. The acid is always in exceſs.

1436 Properties. 2. This ſalt is rarely cryſtallized, but moſt frequently in the form of white powder, or in that of a gelatinous maſs. It has an aſtringent, acid, and ſharp taſte. It reddens the tincture of turnſole and of violets. It is extremely deliqueſcent in the air, and very ſoluble in water. When it is expoſed to heat it melts, and is decompoſed. The acid is ſeparated, and the pure alumina remains behind. It is decompoſed in the ſame way as the other muriates.

7. Hyperoxymuriate of Alumina.

1. This ſalt is prepared by paſſing oxymuriatic acid gas through water in which newly precipitated alumina is ſuſpended. The alumina diſappears, and when ſulphuric acid is poured into the ſolution, a ſtrong ſmell of hyperoxymuriatic acid gas is perceived.

2. This ſalt is deliqueſcent, and it is ſoluble in alcohol. Mr Chenevix could not aſcertain the proportion of its principles *.

8. Fluate of Alumina.

The combination of fluoric acid and alumina, affords a ſalt which cannot be cryſtallized, but which is in the form of a jelly. It has always an exceſs of acid, and an aſtringent taſte. It is decompoſed by all the earthy and alkaline baſes. With the latter it forms triple ſalts.

9. Borate of Alumina.

It is extremely difficult to form a compound of alumina and boracic acid by direct combination. This ſalt may be formed by mixing together a ſolution of borate of ſoda, with a ſolution of ſulphate of alumina. Its properties have not been examined.

10. Phoſphate of Alumina.

This ſalt is little known. By ſaturating phoſphoric acid with alumina, a white powdery maſs is obtained, which has little taſte, except there be an exceſs of acid, and then it ſeems to form an acidulous ſalt. It melts under the blow-pipe into a tranſparent globule, without decompoſition. It is decompoſed by the alkalies, ſome of the earths, and the acids.

11. Phoſphite of Alumina.

1. This ſalt is formed by the direct combination of phoſphorous acid with alumina. The ſolution is to be evaporated to a proper conſiſtence.

2. The phoſphite of alumina does not cryſtallize, but forms a thick, viſcid, gummy maſs, which becomes dry and ſolid in the air. It has an aſtringent taſte, is very ſoluble in water, ſwells up when it is heated, and gives out a phoſphoric light. It is decompoſed by all the alkaline and earthy baſes.

12. Carbonate of Alumina.

Little is known of the combination of carbonic acid and alumina. Bergman had obſerved, when alum was precipitated by an alkaline carbonate, that very little or no efferveſcence took place; he therefore concluded, that the carbonic acid, not being driven off, muſt have combined with the alumina which was precipitated. And beſides he found, that the liquid contained a portion of carbonate of alumina, which is depoſited ſome hours or ſome days afterwards by the evaporation of the carbonic acid, which held it in ſolution. 1437 This compound little known.

Common clay, which is a mixture of alumina and ſilica, contains a certain portion of carbonic acid, which is diſengaged by the application of ſtrong heat. He obtained from one ſpecies of clay, ſeveral times its volume of this acid, mixed with a ſmall portion of hydrogen gas. It is owing to the ſame combination of carbonic acid, that clays, treated with acids, efferveſce, without containing any carbonate of lime.

According to Sauſſure, alumina is diſſolved in water, which is ſaturated with carbonic acid; but when the ſolution is expoſed to the air, it is decompoſed. 1438 The acid is combined with water.

13. Arſeniate of Alumina.

This ſalt is formed by diſſolving alumina in arſenic acid, and evaporating the ſolution to dryneſs. A thick maſs is thus obtained, which is inſoluble in water. It is decompoſed by the ſulphuric, nitric, and muriatic acids, as well as by the earthy and alkaline baſes.

14. Tungſtate of Alumina.

This ſalt has not been examined.

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* Phil. Tranſ. 1802, p. 149.

15. Molybdate of Alumina.
16. Chromate of Alumina. Unknown.
17. Columbate of Alumina.

18. Acetate of Alumina.

The acetic acid enters into combination with alumina, and forms with it ſmall, needle-ſhaped cryſtals, which are ſoft, deliqueſcent, and have an aſtringent taſte. The ſpecific gravity of this ſalt is 1.245. Its other properties are unknown.

19. Oxalate of Alumina.

Oxalic acid very readily combines with alumina. When the ſolution is evaporated, a yellowiſh, ſoft, tranſparent maſs is obtained, but it does not cryſtallize. 1439 Properties. This ſalt has an aſtringent taſte, is deliqueſcent, and reddens the tincture of turnſole. When it is heated, it ſwells up, is deprived of its acid, and the alumina remains behind, ſlightly coloured. It is decompoſed by the ſtronger acids.

1440 Compoſition.

The component parts of this ſalt are,

Acid and water	56
Alumina	44
	100

20. Tartrate of Alumina.

Alumina enters into combination with tartaric acid, and forms an uncryſtallized, gelatinous maſs, which has an aſtringent taſte, is not deliqueſcent in the air, but is ſoluble in water.

21. Citrate of Alumina.

The properties of this ſalt have not been examined.

22. Malate of Alumina.

When malic acid is added to a ſolution containing alumina, a precipitate is formed, which is ſcarcely ſoluble in water.

23. Gallate of Alumina.

If pure alumina be added to a ſolution of nut-galls, an inſoluble compound is formed with the tannin and extract. The liquid remained clear and white, and it afforded by evaporation, ſmall cryſtals, which are gallate of alumina with exceſs of acid *.

24. Benzoate of Alumina.

The compound of benzoic acid and alumina affords a ſalt, which cryſtallizes in an arboreſcent form. It has a bitter taſte, is deliqueſcent in the air, ſoluble in water, is decompoſed by the action of heat, and even by moſt of the vegetable acids.

25. Succinate of Alumina.

The compound of ſuccinic acid and alumina affords ſalts which cryſtallize in the form of priſms, and are eaſily decompoſed by heat.

26. Saccolate of Alumina.

This compound of ſaclactic acid and alumina forms a ſalt which is inſoluble in water.

27. Camphorate of Alumina.

1441 Preparation.

1. The compound of camphoric acid and alumina is formed by precipitating alumina by means of ammonia, waſhing the precipitate, and diluting it with diſtilled water. Cryſtals of camphoric acid are then to be added. The mixture is to be heated, filtered, and evaporated.

1442 Properties.

2. A white powder is thus obtained, which has a bitter, acid, and aſtringent taſte. It reddens vegetable blues. This ſalt is ſcarcely altered by expoſure to the air. Water diſſolves about $\frac{1}{200}$ part of its weight. Boiling water diſſolves it more readily; but on cooling, a precipitate is formed. When it is expoſed to heat, it ſwells up, and the acid is volatilized. By the action of the blow-pipe, a blue flame is produced, the ſalt is decompoſed, and the pure alumina remains behind. This ſalt is decompoſed by the mineral acids, and even by ſome of the vegetable acids. It is alſo decompoſed by the nitrates of lime and barytes *.

28. Suberate of Alumina.

The compound of ſuberic acid and alumina may be formed by evaporating the ſolution with a very moderate heat, in a large open veſſel. 1443 Properties. This ſalt does not cryſtallize; but the dried matter which is obtained, is tranſparent, of a yellowiſh colour, and has a ſtyptic, bitteriſh taſte. When too much heat is employed, the ſalt melts and blackens. It reddens the tincture of turnſole, and is ſlightly deliqueſcent in the air. Expoſed to the action of the blow-pipe, the acid is volatilized and decompoſed, and the alumina remains behind. It is decompoſed by the mineral acids, the earths, and the alkalies †.

29. Mellate of Alumina.

The properties of this ſalt are unknown.

30. Lactate of Alumina.

This is a deliqueſcent ſalt.

SECT. VI. *Of Silica and its Combinations.*

1444 Hiſtory.

1. Silica has been diſtinguiſhed by the names of *ſiliceous earth*, or *quartzy earth*, becauſe it is obtained from *ſilex*, or flint, and from the ſtone called *quartz*. This earth exiſts in great abundance in nature, and it conſtitutes the baſes of ſome of the hardeſt ſtones of which the nucleus of the globe conſiſts; and, on account of its great abundance, it has been regarded as the primitive or elementary earth, the baſe of all the other earths. Silica forms one of the conſtituent parts of moſt ſtony bodies; but it exiſts in greateſt abundance in agates, jaſper, flints, quartz, and rock cryſtal; in the latter it is nearly in a ſtate of purity.

1445 Preparation.

2. But to obtain it perfectly pure, a quantity of quartz or rock cryſtal may be expoſed to a red heat. When it is taken from the fire, and while it is yet hot, it is ſuddenly immerſed in cold water. It is then to be reduced to powder; and, if tranſparent rock cryſtal has been employed, it is then in a ſtate of tolerable purity. To have it perfectly pure, mix one part of the pounded ſtone, with three parts of potaſh, and expoſe them in a crucible to heat which is ſufficient for the fuſion of the mixture. The maſs thus obtained is ſoluble in water. Add a ſufficient quantity of water for its ſolution, and drop in muriatic acid, as long as

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* *Phil. Tranſ.* 1803, p. 244.

* *Ann. de Chim.* xxvii. p. 34.

† *Ibid.* xxiii. p 56.

there is any precipitate. Let this be repeatedly waſhed with water, and dried. The ſubſtance thus obtained is pure ſilica.

1446 Properties. 3. It is in the form of a very fine white powder, which has neither taſte nor ſmell. The particles are rough and harſh to the feel, as when they are rubbed between the fingers, or touched with the tongue. The ſpecific gravity is 2.66.

1447 Action of heat, &c. 4. Light has no action on ſilica; and it is one of the peculiar characters of this earth, that it reſiſts, unchanged, the greateſt degree of heat.

5. There is no action between ſilica and oxygen, azote or hydrogen, nor is it changed by expoſure to the air. It is not acted upon by carbone, phoſphorus, or ſulphur. It is inſoluble in water; but in a ſtate of minute diviſion, it abſorbs a conſiderable portion, and forms with this liquid, a tranſparent jelly. When it is expoſed to the air, the whole of the moiſture is evaporated.

1448 Cryſtals. 6. Silica is frequently found in nature in the cryſtallized form, and then it is diſtinguiſhed by the name of *rock cryſtal*. It is moſt commonly in hexagonal priſms, terminated by hexagonal pyramids. Cryſtals of ſilica have alſo been formed artificially. In a ſolution of ſilica in fluoric acid which had remained at reſt for two years, Bergman found cryſtals, ſome of which were cubes, and ſome had truncated angles, at the bottom of the veſſel. Cryſtals of ſilica have alſo been formed, by diluting largely with water, the combination of ſilica and potaſh, and allowing it to remain for a long time. Profeſſor Scigling of Erfurt obtained cryſtals from a ſolution which had been kept eight years in a glaſs veſſel. A cruſt was formed on the top, compoſed of carbonate of potaſh and cryſtallized ſilica. The cryſtals of the latter were in the form of tetrahedral pyramids, perfectly tranſparent, and ſo hard as to ſtrike fire with ſteel.

1449 Action of acids. 7. Silica is only acted on by a very few of the acids. Theſe are, the phoſphoric and boracic, which combine with it by fuſion, and the fluoric, which diſſolves ſilica either in the gaſeous or liquid ſtate. When ſilica is held in ſolution in water by means of an alkali, it is alſo diſſolved by the muriatic acid.

1450 Of alkalies. 8. The alkalies have a very powerful action on this earth. In the preparation of the pure earth, it was combined with potaſh by means of fuſion. This compound is different in its nature and properties, according to the proportions of the ſilica and the alkali. Two or three parts of potaſh with one of ſilica, form a compound which is deliqueſcent in the air, and ſoluble in water. This was formerly diſtinguiſhed by the name *liquor ſilicum*, or *liquor of flints*. It is now called *ſilicated alkali*. When this ſolution is long expoſed to the air, the earth is depoſited in a flaky gelatinous form. It is decompoſed by acids, which combine with the alkali, and the pure earth falls to the bottom in the ſtate of fine powder. When the ſolution is largely diluted with water, and if a greater quantity of the acid be added than is ſufficient to ſaturate the alkali, the ſilica remains in ſolution. This is particularly the caſe when muriatic acid is employed. When the ſilica is in greater proportion than the potaſh, a compound is formed which is poſſeſſed of very different properties. The ſubſtance thus obtained is glaſs.

1451 Glaſs.

1452 Of earths. 9. This earth alſo enters into combination with ſome of the earths. If to a ſolution of the liquor of flints, lime water be added, a precipitate is formed, which is found to be a compound of ſilica and lime. Silica alſo combines with lime by means of heat, and in certain proportions a glaſs is formed.

The following table, drawn up by Mr Kirwan, exhibits the effects of heat on theſe earths in different proportions *.

Proportions.	Wedgw.	Effect.
50 Lime 50 Silica	150°	Melted into a maſs between porcelain and enamel, of a white colour, ſemitranſparent at the edges, and which gave feeble ſparks with ſteel.
80 Silica 20 Lime	156°	Not melted, but formed a brittle maſs.
80 Lime 20 Silica	156°	Formed a yellowiſh-white looſe powder.

10. Silica enters into combination with barytes. The following table will ſhew the effect of different proportions of theſe earths, as they were aſcertained by Mr Kirwan †.

Proportions.	Wedgw.	Effect.
80 Silica 20 Barytes	155°	Formed a white brittle maſs.
75 Silica 20 Barytes	150°	A brittle hard maſs, ſemitranſparent at the edges.
66 Silica 33 Barytes	150°	Melted into a hard, ſomewhat porous, porcelain maſs.
50 Silica 50 Barytes	148°	A hard maſs not melted.
80 Barytes 20 Silica	148°	The edges melted into a pale greeniſh maſs, between a porcelain and an enamel.
75 Barytes 25 Silica	150°	Melted into a ſomewhat porous porcelain maſs.
66 Barytes 33 Silica	150°	Melted into a yellowiſh, and partly greeniſh white, porous porcelain.

11. Silica alſo enters into combination with ſtrontites. Three parts of ſtrontites and one of ſilica, ſtrongly heated in a ſilver crucible for an hour, afforded a gray, ſonorous, vitreous maſs, which has no taſte, and is inſoluble in water.

12. Siliceous earth enters with difficulty into combination with magneſia; but if equal parts of ſilica and magneſia be expoſed to very ſtrong heat, they melt into a white enamel.

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* *Mineral.* i. p. 56.

† *Ibid.* 57.

13. But the moſt important compounds of all the earths are thoſe of ſilica and alumina. Theſe earths may be combined together, as appears from the experiments of Guyton, in the humid way. He mixed together equal parts of alumina diſſolved by means of potaſh, and of ſilica held in ſolution by the ſame alkali. When the ſolutions came into contact, a brown zone was immediately formed, which ſpread by agitation through the whole maſs, and communicated to it a yellowiſh colour. The mixture was no farther changed during the ſpace of an hour, although it was occaſionally ſtirred with a glaſs rod; but at the end of that time the whole maſs aſſumed the appearance of a thick, opaque, white jelly *. 1453 Porcelain. When the ſilica and alumina are mixed together, and formed into a paſte with water, and expoſed to heat, they ſtrongly cohere, and aſſume a conſiderable degree of hardneſs. This compound forms the baſes of all kinds of pottery and porcelain.

I. Compounds of Silica with Acids.

1. Muriate of Silica.

1454 Preparation. When muriatic acid is poured upon a ſolution of ſilicated potaſh, part of the ſilica remains in the ſolution combined with the acid. To this compound Fourcroy has given the name of *muriate of ſilica*. This

1455 Properties. ſolution, which is perfectly tranſparent, is always acid. When it is concentrated by ſlow evaporation, it aſſumes the form of a tranſparent jelly. But if the ſolution be boiled, it is decompoſed, and the ſilica is precipitated in the form of ſmall cryſtalline particles, ſo that it is totally ſeparated from the water and the acid †.

2. Fluate of Silica.

1456 Preparation. Fluoric acid combines with ſilica, either in the gaſeous or liquid ſtate. When it is diſengaged from lime in the ſtate of gas, by means of an acid, if the proceſs be performed in glaſs veſſels, they are corroded. The fluoric acid in the ſtate of gas combines with the ſilica, and retains it, even when it is condenſed by water. This earth may be precipitated from the liquid ſolution by means of an alkali. When fluoric acid gas is condenſed by water, part of the ſilica with which it was combined, is precipitated; but this portion is at laſt diſſolved by new additions of the acid, ſo that the ſalt is in the ſtate of an acidulous fluate. If this ſolution be evaporated, a quantity of ſilica, correſponding to the portion of acid diſengaged, is depoſited, and the liquid which remains, contains a portion in proportion to that of the acid which is left in the ſolution ‡.

3. Fluate of Potaſh and Silica.

This triple ſalt is formed, when a ſolution of fluate of potaſh is expoſed to heat in glaſs veſſels; or, when the fluoric acid which has been prepared in glaſs veſſels is combined with potaſh. But the nature of this triple ſalt has not been examined.

4. Fluate of Soda and Silica.

This triple ſalt is formed in the ſame way as the former.

5. Borate of Silica.

Boracic acid and ſilica combine together by means of a ſtrong heat, and form a tranſparent glaſs. To this Fourcroy has given the name of *borate of ſilica*. This compound has no taſte, is not altered by the air, nor is it ſoluble in water.

6. Phoſphate of Silica.

This compound of phoſphoric acid and ſilica is formed by means of fuſion; and the compound is a hard, denſe, tranſparent glaſs. When it is expoſed to ſtrong heat, it combines with the alkalies, and forms a triple ſalt. It is not decompoſed by any of the acids. This ſubſtance is employed in the fabrication of artificial gems.

SECT. VII. *Of Yttria and its Combinations.*

1. This earth was diſcovered by Gadolin in 1794; 1457 Hiſtory. and the account of his analyſis of the mineral from which it is obtained, was publiſhed in the memoirs of the Swediſh academy, and in Crell's Annals for the year 1796. In 1797 Ekeberg analyzed the ſame mineral, and confirmed the reſults of Gadolin. To the new earth found in this mineral, Ekeberg gave the name of *yttria*, derived from *Ytterby*, a place in Sweden where the ſtone is found. The ſame mineral was afterwards analyzed by Vauquelin and Klaproth, about the year 1800. The mineral from which this earth is obtained, has received the name of gadolinite, is of a black colour, has a vitreous fracture, and its ſpecific gravity is 4.0497. It is magnetic. When it is heated with borax, it melts, and communicates to the ſalt a yellowiſh colour inclining to violet. The component parts of this mineral are,

Yttria,	.47
Silica,	.25
Oxyde of iron,	.18
Alumina,	.04
	.94

2. Yttria is obtained from this mineral, by reducing 1458 Preparation. it to powder, and adding a mixture of nitric and muriatic acids, till the whole is decompoſed. The ſolution is then to be filtered, and evaporated to dryneſs. If then it be diluted with water, the ſilica will remain behind. The liquid which paſſed through the filter is alſo to be evaporated to dryneſs, and what remains is to be expoſed to a red heat in a cloſe veſſel. It is afterwards diſſolved in water, and filtered. The liquid which paſſes through the filter is tranſparent and colourleſs. By adding a ſolution of ammonia, a precipitate is formed, which being collected, is pure yttria.

3. This earth is in the ſtate of a white powder. It 1459 Properties. has neither taſte nor ſmell. It is not fuſible. It is not ſoluble in water, or in any of the cauſtic fixed alkalies, but it readily diſſolves in carbonate of ammonia. The ſpecific gravity of this earth is 4.842.

4. This earth undergoes no change by the action of light. It is not acted on by oxygen, azote, or hydrogen, nor does it combine with ſulphur. It forms compounds

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* Ann. de Chim. xxxi. p. 248.

† Fourcroy, iii. 213.

‡ Ibid. iii. p. 310.

pounds with the acids. Theſe ſalts have a ſweetiſh, auſtere taſte, and ſome of them have a red colour,

I. Compounds of Yttria with the Acids.

1. Sulphate of Yttria.

1460 Preparation. 1. Sulphuric acid combines readily with yttria, and during the combination there is an evolution of caloric; and as the union goes on, the ſalt which is formed, cryſtallizes in ſmall brilliant grains.

1461 Properties. 2. Theſe cryſtals are ſometimes irregular, but often have the form of ſix-ſided priſms, terminated by four-ſided ſummits, and are of an amethyſt red colour. This ſalt has a ſweetiſh aſtringent taſte, ſomething like the ſalt of lead. The ſpecific gravity is 2.791. It undergoes no change by expoſure to the air. It is ſoluble in about 50 parts of cold water, but leſs ſo where there is not an exceſs of acid. This ſalt is partially decompoſed when expoſed to a red heat.

2. Sulphite of Yttria.

Unknown.

3. Nitrate of Yttria.

1462 Preparation. Nitric acid combines with yttria by diſſolving the earth in the acid. This ſalt cryſtallizes with difficulty. When it is evaporated by heat, if too much be applied, in place of becoming ſolid as other ſalts, it becomes ſoft, and aſſumes the appearance of a thick, tranſparent honey. When it cools, it becomes hard and brittle. It deliqueſces in the air. When ſulphuric acid is poured into a ſolution of nitrate of yttria, a precipitate is formed which cryſtallizes. Theſe are cryſtals of ſulphate of yttria *.

4. Muriate of Yttria.

This ſalt, which is a compound of muriatic acid and yttria, reſembles the nitrate in many of its properties. It dries with difficulty, is fuſible with a moderate heat, and is deliqueſcent in the air. This ſalt is decompoſed by ammonia.

5. Fluate of Yttria. } Unknown.
6. Borate of Yttria. }

7. Phoſphate of Yttria.

1463 Preparation. Phoſphoric acid does not precipitate yttria from its combination with the other acids; but the phoſphate of ſoda decompoſes the ſalts of yttria, and forms a phoſphate of yttria, which is precipitated in white, gelatinous flakes †.

8. Phoſphite of Yttria.

Unknown.

9. Carbonate of Yttria.

1464 Preparation. This compound of carbonic acid and yttria was formed by Klaproth, by precipitating the earth by means of an alkaline carbonate, from its ſolution in acids. The carbonate of yttria is in the form of an inſipid white powder. It is inſoluble in water.

The component parts of this ſalt are,

Acid	18
Yttria	55
Water	27
	100

10. Arſeniate of Yttria.

This ſalt is formed by boiling the earth in the acid. A white powder is precipitated, which is arſeniate of yttria.

11. Tungſtate of Yttria. }
12. Molybdate of Yttria. } Unknown.
13. Chromate of Yttria. }
14. Columbate of Yttria. }

15. Acetate of Yttria.

This ſalt is formed by the direct combination of the earth with the acid. By evaporating the ſolution, a ſalt is obtained in cryſtals. Theſe cryſtals, which are of a red colour, are in the form of ſix-ſided plates obliquely truncated. This ſalt undergoes no change by expoſure to the air.

16. Oxalate of Yttria.

This ſalt is formed by adding oxalic acid to the ſolution of yttria in acids. A precipitate is formed in the ſtate of a white powder, which is inſoluble in water. It may be obtained alſo by employing the oxalate of ammonia.

17. Tartrate of Yttria.

This compound is formed by precipitating yttria from its ſolution in acids by means of tartrate of potaſh. This ſalt is ſoluble in water.

18. Citrate of Yttria. }
19. Malate of Yttria. } Unknown.
20. Gallate of Yttria. }
21. Benzoate of Yttria. }

22. Succinate of Yttria.

If the ſuccinate of ſoda be added to a concentrated ſolution of muriate or acetate of yttria, a precipitate is formed, which is the ſuccinate of yttria in the ſtate of cubic cryſtals.

23. Saccolate of Yttria. }
24. Camphorate of Yttria. }
25. Suberate of Yttria. } Unknown.
26. Mellate of Yttria. }
27. Lactate of Yttria. }

28. Pruſſiate of Yttria.

The pruſſiate of potaſh cryſtallized and re-diſſolved in water, cauſes a precipitate in the ſolution of yttria in acids. This is in the form of a white, gritty matter *.

SECT. VIII. *Of Glucina and its Combinations.*

1465 Hiſtory. 1. This earth was diſcovered by Vauquelin in the year 1789. He was requeſted by Haüy to analyze the beryl, to aſcertain whether its conſtituent parts were the ſame with thoſe of the emerald, which the latter had conjectured, in obſerving a perfect correſpondence in ſtructure, hardneſs, and ſpecific gravity. In the courſe of this analyſis, Vauquelin diſcovered the new earth, to which, from its properties, he gave the name of *glucina*, from the Greek word γλυκος, which ſignifies ſweet. The ſame experiments were repeated by Klaproth and Bindheim, and the reſults obtained by Vauquelin were confirmed.

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* *Ann. de Chim.* xxxvi. 143.

† *Ibid.* 158.

* *Ann. de Chim.* xxxvi. p. 158.

1466 Preparation. 2. This earth is obtained by the following proceſs. One hundred parts of the beryl or emerald, reduced to a fine powder, are fuſed with 300 parts of cauſtic potaſh. The fuſed maſs is then diluted with diſtilled water, and diſſolved in muriatic acid. The ſolution is to be evaporated to dryneſs, taking care to ſtir it towards the end of the evaporation. Dilute the reſiduum with a large quantity of water, and filter it. The ſilica is thus ſeparated by means of the firſt proceſs. The filtered ſolution, which contains the muriates of alumina and glucina, is precipitated by carbonate of potaſh. The precipitate is to be well waſhed, and diſſolved in ſulphuric acid. Add to this ſolution, a quantity of ſulphate of potaſh, and evaporate to obtain cryſtallized alum. When by a new addition of ſulphate of potaſh, and by a new evaporation, the ſolution yields no more alum, add to it a ſolution of carbonate of ammonia in exceſs, and agitate it well. The glucina, after being depoſited, is diſſolved by means of the exceſs of this ſalt, and the ſmall quantity of alumina which may remain is precipitated without being diſſolved. After ſome hours, when the aluminous precipitate is not diminiſhed in volume by a new addition of carbonate of ammonia, and agitation, the ſolution is to be filtered, and boiled in a glaſs matraſs, and as the carbonate evaporates, there is precipitated a white, gritty powder, which is carbonate of glucina. The carbonic acid may be driven off, by expoſing the powder in a crucible to a red heat *.

1467 Properties. 3. Glucina prepared by this proceſs, is in the form of a ſoft powder, or light white fragments, which are inſipid to the taſte, and adhere to the tongue. The ſpecific gravity is 2.967 †. It is altogether infuſible in the fire, and it neither contracts nor becomes harder, like alumina. It has no effect on vegetable colours.

1468 Hydroſulphuret. 4. There is no action between glucina and oxygen, azotic, or hydrogen gaſes. It is not changed by expoſure to the air, nor is it acted on by carbone, phoſphorus, or ſulphur. It combines with ſulphurated hydrogen. When ſulphurated hydrogen gas is made to paſs into water in which this earth is ſuſpended, it combines with it, and forms a hydroſulphuret, whoſe properties are ſimilar to thoſe of the other hydroſulphurets.

1469 Action of water. 5. Glucina is inſoluble in water; but it forms with this liquid in ſmall quantity, a paſte which is ſlightly ductile, but has leſs tenacity than that of alumina.

1470 Of acids. 6. Glucina combines readily with all the acids, and forms with moſt of them ſoluble ſalts, which are diſtinguiſhed by a ſweet and ſlightly aſtringent taſte. Its affinities are in the following order.

Sulphuric acid,
Nitric,
Muriatic,
Phoſphoric,
Fluoric,
Boracic,
Carbonic.

1471 Of alkalies. 7. This earth is ſoluble in ſolutions of the fixed alkalies. It is alſo ſoluble in carbonate of ammonia, but it is inſoluble in pure ammonia.

1472 Characteriſtic properties. 8. The characteriſtic properties of this earth are, according to Vauquelin, the following.

a. It forms with acids ſweetiſh and ſlightly aſtringent ſalts.

b. It is ſoluble in ſulphuric acid when a little in exceſs.

c. It decompoſes aluminous ſalts, by ſeparating the earth when it is boiled in their ſolutions.

d. The ſalts of glucina are completely precipitated by ammonia.

e. It is ſoluble in the liquid carbonate of ammonia.

f. The affinity of this earth for the acids is between that of magneſia and alumina *.

I. Compounds of Glucina with Acids.

1. Sulphate of Glucina.

1473 Preparation. 1. This ſalt, which was firſt diſcovered by Vauquelin, is prepared by the direct combination of ſulphuric acid with the earth, either in the pure ſtate, or in that of carbonate. The ſolution is to be evaporated to the conſiſtence of ſyrup, and cryſtals are obtained on cooling.

1474 Properties. 2. This ſalt cryſtallizes with difficulty in the form of ſmall needles; but their form has not been accurately aſcertained. It has a ſweet, and ſomewhat aſtringent taſte. It is not perceptibly altered by expoſure to the air, and is very ſoluble in water.

1475 Action of heat. 3. When it is expoſed to heat, it melts, ſwells up, and then dries. With a red heat it is entirely decompoſed, the acid is driven off in the ſtate of vapour, and the pure earth remains behind.

1476 Of acids, &c. 4. This ſalt is not decompoſed by any of the acids, but it is decompoſed by the alkaline and moſt of the earthy baſes. The infuſion of nut-galls added to a ſolution of this ſalt produces a yellowiſh white precipitate, which is characteriſtic of the ſalt †.

2. Sulphite of Glucina.

This ſalt is yet unknown.

3. Nitrate of Glucina.

1477 Preparation. 1. The compound of nitric acid and glucina is formed by the direct combination of the acid and earth in a ſtate of purity. The ſolution is evaporated by a moderate heat to dryneſs, and then the ſalt is obtained in the ſtate of powder.

1478 Properties. 2. The nitrate of glucina does not cryſtallize. It is either in the form of powder, or in that of a ſoft ductile maſs. The taſte is ſweetiſh and aſtringent.

1479 Action of heat. 3. It is extremely deliqueſcent in the air, and is very ſoluble in water. It readily melts when expoſed to heat, and if the heat be increaſed it is decompoſed; the acid is driven off in the gaſeous form, and the earth remains behind. It is only decompoſed by ſulphuric acid ‡.

4. Nitrite of Glucina.

Unknown.

5. Muriate

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* *Fourcroy*, ii. p. 157.

† *Annal. de Chim.* xliii. 277.

* *Fourcroy*, ii. 161.

† *Fourcroy Connaiſs. Chim.* iii. p. 49.

‡ *Ibid.* 146.

5. Muriate of Glucina.

This ſalt, according to Vauquelin, by whom only it has been deſcribed, comes very near the nitrate of glucina in its properties. It ſeems to cryſtallize with more facility, but the cryſtals are ſo ſmall that the form cannot be determined. It does not deliqueſce in the air. When it is diſſolved in alcohol, and diluted with water, it affords a very agreeable ſweet liquor.

It is decompoſed by heat, by the ſulphuric acid, the nitric, and by the phoſphoric with the aſſiſtance of heat.

6. Fluate of Glucina. }
7. Borate of Glucina, } Unknown.

8. Phoſphate of Glucina.

1480 Preparation. 1. Vauquelin procured this ſalt by adding the phoſphate of ſoda to the ſolution of the nitrate, the ſulphate, or muriate of glucina. A copious mucilaginous matter is inſtantly precipitated. Or it may be obtained by heating together the muriate of glucina and phoſphoric acid in the ſtate of glaſs.

1481 Properties. 2. This ſalt does not cryſtallize, but is in the form of mucilage or of white powder. It has no perceptible taſte. It is not altered by expoſure to the air, and it is inſoluble in water without an exceſs of acid. It is not decompoſed by ſtrong heat. It melts under the blow-pipe into a tranſparent vitreous globule. It is decompoſed by the ſulphuric, nitric, and muriatic acids.

9. Phoſphite of Glucina.

Unknown.

10. Carbonate of Glucina.

1482 Preparation. 1. The compound of carbonic acid and glucina, which was diſcovered by Vauquelin, and only examined by him, is prepared by expoſing the earth to the air, from which it attracts the acid, or by precipitating ſome of the ſoluble ſalts of glucina by means of an alkaline carbonate. The precipitate is to be waſhed with water, and dried in the air.

1483 Properties. 2. This carbonate is in the ſtate of a white powder, ſoft and greaſy to the touch. It has not the ſweet taſte of the other ſalts of glucina. It is not changed by expoſure to the air, and is inſoluble in water. When expoſed to heat, the acid is driven off, and the pure earth remains behind. It is decompoſed by all the acids with a briſk efferveſcence.

11. Carbonate of Ammonia and Glucina.

This triple ſalt is formed by adding the earth of glucina to a ſolution of carbonate of ammonia. It is ſoluble in the ſame quantity of water which holds the carbonate of ammonia in ſolution. Its other properties are unknown.

12. Arſeniate of Glucina. }
13. Tungſtate of Glucina. }
14. Molybdate of Glucina. } Unknown.
15. Chromate of Glucina. }
16. Columbate of Glucina. }

17. Acetate of Glucina.

Glucina readily diſſolves in acetic acid. This ſalt does not cryſtallize; but by evaporation it is reduced to a gummy ſubſtance, which becomes ſlowly dry and brittle. For a long time it retains a kind of ductility. The taſte is ſweet and ſtrongly aſtringent.

18. Oxalate of Glucina. }
19. Tartrate of Glucina. }
20. Citrate of Glucina. } Unknown.
21. Malate of Glucina. }
22. Gallate of Glucina. }
23. Benzoate of Glucina. }

24. Succinate of Glucina.

This ſalt, according to Ekeberg, is formed by precipitating the earth from its ſolutions, by means of the ſuccinates. It is therefore nearly inſoluble.

25. Saccolate of Glucina. }
26. Camphorate of Glucina. }
27. Suberate of Glucina. }
28. Mellate of Glucina. } Unknown.
29. Lactate of Glucina. }
30. Pruſſiate of Glucina. }
31. Sebate of Glucina. }

SECT. IX. *Of ZIRCONIA and its Combinations.*

1484 Hiſtory. 1. The name of this earth is derived from a ſtone called *zircon* or *jargon*, which is found in the iſland of Ceylon. It was from this ſtone that Klaproth extracted the earth, ſome time before the year 1793. He ſoon after found the ſame earth in the oriental hyacinth. By this diſcovery, Guyton was led to analyze the hyacinths of France; and in thoſe which were collected in the river of Expailly, he detected the ſame earth. The experiments of Klaproth and Guyton were repeated by Vauquelin, and their reſults were confirmed, ſo that the nature and properties of this earth have been fully developed.

1485 Preparation. 2. Zirconia is extracted from this mineral, in which alone it has been found, by the following proceſs. A quantity of the mineral is to be reduced to fine powder, and fuſed with five or ſix times its weight of pure potaſh, in a ſilver crucible. The fuſed maſs is then diſſolved in water, by which means the alkali is ſeparated. The reſiduum is then diſſolved in muriatic acid, which is to be heated, to ſeparate the ſilica; and when no farther precipitate appears by means of heat, add a cauſtic fixed alkali. Another precipitate is formed, which is to be well waſhed and dried. This is pure zirconia.

1486 Properties. 3. Zirconia thus prepared, is in the ſtate of fine white powder, which is nearly ſoft to the touch, and without taſte or ſmell. When it retains water, it aſſumes the form of a jelly, and is ſemitranſparent. The ſpecific gravity is 4.3.

1487 Action of heat. 4. Light has no action on this earth. When it is expoſed to the heat of the blow-pipe, it remains infuſible, but gives out a yellowiſh, phoſphoric light. Heated in a charcoal crucible, and ſurrounded with powdered charcoal, it undergoes a kind of fuſion, but without becoming tranſparent, or aſſuming a vitreous form. It becomes extremely hard, ſtrikes fire with ſteel, and ſcratches glaſs.

5. There is no action between zirconia and oxygen or azotic gaſes, nor is it changed by expoſure to the

air. It is not acted on by hydrogen, carbone, phoſphorus, or ſulphur.

1488 Of water. 6. This earth is inſoluble in water; but it mixes with a conſiderable portion of this fluid, and forms with it a tranſparent jelly. If in this ſtate it be ſlowly dried, it retains the water, and aſſumes a yellowiſh colour, and ſomething of the tranſparency of gum arabic *. When it is dried in a very high temperature, it loſes more than one-third of its weight. After having been expoſed to a red heat, it becomes of a gray colour, harſh to the feel, and leſs ſoluble in acids.

1489 Of acids. 7. Zirconia combines with the acids, and forms with them peculiar ſalts. Many of theſe are inſoluble in water, and are diſtinguiſhed by an aſtringent taſte.

1490 Affinities. The order of the affinities of this earth, is the following:

Vegetable acids,
Sulphuric,
Muriatic,
Nitric.

1491 Action of alkalies. 8. Zirconia does not combine with the alkalies by fuſion, and is inſoluble in liquid alkalies. It may be diſſolved, however, by the alkaline carbonates.

I. Compounds of Zirconia with the Acids.

1. Sulphate of Zirconia.

1492 Preparation and properties. 1. This ſalt is formed by the direct combination of the earth with ſulphuric acid. The ſolution is to be evaporated to dryneſs. The ſalt thus obtained is in the form of a white powder, which is very friable. Sometimes it is in the form of cryſtals like ſmall needles. It has no taſte, is not changed by expoſure to the air, and is inſoluble in water.

1493 Action of heat. 2. This ſalt is readily decompoſed by heat, the acid is driven off, and the earth remains behind. When it is boiled in water, the earth is precipitated, and the acid remains in the liquid. At a high temperature it is decompoſed by charcoal, and converted into a ſulphuret which is ſoluble in water, and the ſolution furniſhes by evaporation, cryſtals of hydroſulphuret of zirconia †.

2. Sulphite of Zirconia.

Unknown.

3. Nitrate of Zirconia.

1494 Preparation. 1. This ſalt is formed by the direct combination of zirconia with concentrated nitric acid; and by evaporation it is obtained in the form of a yellow, tranſparent, viſcid maſs, which dries with difficulty.

1495 Properties. 2. This ſalt has a ſtyptic and aſtringent taſte, and leaves on the tongue a thick matter, which proceeds from a decompoſition of the ſalt by means of the ſaliva.

1496 Action of water and heat. 3. When nitrate of zirconia, after being evaporated, is put into diſtilled water, a very ſmall quantity only is diſſolved. The greateſt part remains under the form of gelatinous and tranſparent flakes. This ſalt is very readily decompoſed by heat.

1497 Of acids, &c. 4. It is alſo decompoſed by ſulphuric acid, which forms in the ſolution a white precipitate, ſoluble in exceſs of acid; by carbonate of ammonia, which produces a precipitate, ſoluble in an exceſs of this ſalt; and by an infuſion of nut galls in alcohol, which affords a white precipitate, ſoluble in an exceſs of this infuſion. But if the zirconia contain iron, the colour of the precipitate is bluiſh gray, of which a part remains in the ſolution, communicating to the liquor a pure blue colour. When this liquid is mixed with carbonate of ammonia, it affords a purple matter, by the refracted rays, but of a violet colour by reflected light. Cryſtallized gallic acid alſo precipitates the nitrate of zirconia, of a bluiſh gray colour. Moſt of the other vegetable acids alſo decompoſe this ſalt, and form combinations with the earth which are inſoluble in water ‡.

4. Nitrite of Zirconia.

Unknown.

5. Muriate of Zirconia.

1498 Preparation. 1. Of all the acids, the muriatic combines moſt readily with zirconia, when the latter is in the ſtate of carbonate. This ſalt was firſt formed by Klaproth, and its properties were afterwards more particularly inveſtigated by Vauquelin.

1499 Properties. 2. The muriate of zirconia has no colour, but poſſeſſes a very aſtringent taſte, is very ſoluble in water, and alſo in alcohol. By ſlow evaporation, it affords ſmall, tranſparent, needle-formed cryſtals, whoſe figure has not been determined. When muriate of zirconia contains any portion of ſilica, the cryſtals are cubical, have little conſiſtence, and reſemble a jelly. Theſe cryſtals, expoſed to the air, gradually loſe their tranſparency, and are diminiſhed in volume. There are formed, in the middle of the maſs, white ſilky cryſtals in the ſhape of needles, which ariſe from the cubes.

1500 Action of heat. 3. Muriate of zirconia is decompoſed by heat, which drives off the acid. It is even decompoſed in the mouth by means of the ſaliva.

1501 Of acids, &c. 4. *a.* It is alſo decompoſed by ſulphuric acid, which forms a precipitate with the earth in heavy white flakes, while another part is retained in ſolution by the muriatic acid. But by the aſſiſtance of heat, the latter is diſſipated, and the remaining part of the ſulphate of zirconia is depoſited. If the evaporation be ſtopped before it is brought to a ſtate of dryneſs, it aſſumes the appearance of a jelly by cooling. The ſulphate of zirconia is then ſoluble in muriatic acid.

b. This ſalt is alſo decompoſed by the phoſphoric, citric, tartaric, oxalic, and ſaclactic acids, which forming with its baſe inſoluble compounds, precipitate in the form of white flakes.

c. The gallic acid precipitates the muriate of zirconia in the form of a white matter, if the ſalt has been pure, but of a grayiſh green if it contain iron. In the latter caſe, the precipitate becomes, when dry, of a ſhining black colour, which has the ſame appearance as china ink. The liquid, in which are formed the gallates of zirconia and iron, preſerves a green colour; and although new portions of gallic acid are added, no farther precipitation is produced. But the carbonate of ammonia throws down a copious flaky matter, which has a purple colour, and nearly reſembles that of lees of wine. Thus, it appears, that the gallic acid has a greater affinity for zirconia than the muriatic, and that the gallates of zirconia and iron are ſoluble in muriatic acid.

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* *Ann. de Chim.* xxii. 197.

† *Ibid.* 199.

‡ *Annal. de Chim.* xxii. p. 199.

d. The carbonate of potaſh, when fully ſaturated, decompoſes the muriate of zirconia; and although this ſolution is attended with efferveſcence, the precipitate waſhed and dried in the air, retains a large proportion of carbonic acid; for when this earth is afterwards diſſolved in acids, it produces a briſk efferveſcence. The carbonate of ammonia at firſt forms a precipitate in the ſolution of muriate of zirconia. This precipitate is in great part re-diſſolved by new additions of the ammoniacal ſalt, and there is produced a triple ſalt, which may be decompoſed by heat.

e. A ſolution of ſulphurated hydrogen gas in water, mixed with a ſolution of muriate of zirconia containing iron, becomes turbid, and produces a reddiſh colour; but there is no real precipitate. Hydroſulphuret of ammonia inſtantly precipitates this earth of a fine green colour, which appears black when it is dry. When this precipitate is placed on burning coals, it emits the odour of ſulphurated hydrogen gas, and becomes of a purple blue colour when reduced to powder.

f. Pure alumina decompoſes the muriate of zirconia, with the aid of heat. The alumina is diſſolved, the liquid becomes milky, and aſſumes the form of a jelly as it cools. It has been remarked, when the muriate of zirconia contains iron, it remains in ſolution with the alumina, and the zirconia, which has been precipitated in this way, contains no perceptible portion of this metal.

g. The pruſſiate of mercury produces in the ſolution of muriate of zirconia, a copious white precipitate, which is ſoluble in muriatic acid.

h. A plate of zinc introduced into a ſolution of muriate of zirconia, produces a ſlight efferveſcence. The liquid becomes milky, and aſſumes the appearance of a white ſemitranſparent jelly in a few days *.

6. Fluate of Zirconia.
7. Borate of Zirconia.
8. Phoſphate of Zirconia.
9. Phoſphite of Zirconia.

Unknown.

10. Carbonate of Zirconia.

When an alkaline carbonate in ſolution is added to a ſolution of muriate of zirconia, the earth is precipitated without efferveſcence; and when this precipitate is expoſed to heat in cloſe veſſels, it gives out carbonic acid gas. It alſo enters into combination with the alkaline carbonates, and forms with them triple ſalts. This, Vauquelin obſerves, is one of the remarkable characters of this ſalt.

1502 Compoſition. The component parts of carbonate of zirconia, according to the ſame chemiſt, are,

Acid and water,	44.5
Zirconia,	55.5
	100.0

11. Arſeniate of Zirconia.
12. Tungſtate of Zirconia.
13. Molybdate of Zirconia.
14. Chromate of Zirconia.
15. Columbate of Zirconia.

Unknown.

16. Acetate of Zirconia.

Acetic acid combines with zirconia, and forms with it a ſalt which does not cryſtallize. When the ſolution is evaporated to dryneſs, the acetate of zirconia remains in the ſtate of powder. 1503 Properties. This ſalt has an aſtringent taſte, is not altered by expoſure to the air, and is very ſoluble in water and in alcohol. This ſalt ſeems to have leſs tendency to be decompoſed by heat than the nitrate of zirconia *.

17. Oxalate of Zirconia.
18. Tartrate of Zirconia.
19. Citrate of Zirconia.
20. Malate of Zirconia.

Unknown.

21. Gallate of Zirconia.

Gallic acid added to a ſolution of muriate of zirconia, it has been already mentioned, produces a precipitate of a white matter, which is the gallate of zirconia. The properties of this compound have not been examined.

22. Benzoate of Zirconia.
23. Succinate of Zirconia.
24. Saccolate of Zirconia.
25. Camphorate of Zirconia.
26. Suberate of Zirconia.
27. Mellate of Zirconia.
28. Lactate of Zirconia.
29. Pruſſiate of Zirconia.
30. Sebate of Zirconia.

Unknown.

Chap. XIV. Of METALS.

1504 Importance of metals.

1. The metals, on account of their importance and utility, have always greatly occupied the attention of mankind. Indeed ſuch is their importance, that man could not take a ſingle ſtep in the improvement even of the ſimpleſt of the arts of life, without the aſſiſtance of ſome of the metals. In this view, the origin and improvement of many arts, and the knowledge of metallic ſubſtances, may be, in ſome meaſure, conſidered as coeval. The metals, therefore, became very early, and were probably the firſt objects of chemical inveſtigation. In the extraordinary purſuits of the alchemiſts, they were the ſubjects of their eager reſearches, in the diſcovery of the means of converting the more abundant and baſer metals, as they were called, into thoſe which were more valued, on account of their durability and ſcarcity. They failed of their purpoſe; but their labours were not in vain. The facts which they diſcovered in the progreſs of their inveſtigations, were of no ſmall importance to ſcience.

1505 Characters. 2. The metals are diſtinguiſhed from other ſubſtances by a number of characteriſtic properties. Theſe are, brilliancy, colour, opacity, denſity, hardneſs, elaſticity, ductility, malleability, tenacity, fuſibility, power of conducting caloric and electricity.

1506 Brilliancy. 3. Luſtre or brilliancy is one of the moſt ſtriking characteriſtic properties of metallic ſubſtances, and hence it has been denominated *metallic luſtre*. This is owing to the reflection of a great proportion of the rays of light by metallic ſurfaces. On account of this property, metals are employed in the conſtruction of mirrors. Other ſubſtances, indeed, exhibit the appearance of this brilliancy, which is the caſe with the mineral called *mica*; but in this ſubſtance, as well as every other which is not metallic, it is merely ſuperficial, and it entirely diſappears when the ſurface

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* *Ann. de Chim.* xxii. p. 201.

* *Ann. de Chim.* xxii. p. 206.

is broken, or ſcratched with a ſharp-pointed inſtrument. But the metal, treated in the ſame way, becomes more brilliant. The following is the order in which the metals poſſeſs this luſtre:

Platina,
Steel,
Silver,
Mercury,
Gold,
Copper,
Tin,
Zinc,
Antimony,
Biſmuth,
Lead,
Arſenic,
Cobalt; and the other brittle metals.

1507 Colour. 4. Colour is one of the conſtant properties of metallic ſubſtances, while it is only accidental and variable in other minerals. And as the metals are the moſt opaque, and the denſeſt bodies in nature, colour in them is very intenſe, or rather confounded with their brilliancy. The prevailing colour of metals is white; ſome however are yellow, and others reddiſh. Thoſe of a white colour were formerly diſtinguiſhed by the name of *lunar metals*, becauſe ſilver, which was called *luna*, being placed at the head of theſe metals, has a white colour. Gold, which was diſtinguiſhed by the name of *ſol*, having a yellow colour, gave the name of ſolar metals to ſuch as reſembled it. The colour of metals is permanent, while they remain unaltered; but it is often totally loſt when they enter into new combinations.

1508 Opacity. 5. It is generally admitted, that all metallic ſubſtances are perfectly opaque. Newton indeed obſerved, that gold-leaf when reduced to $\frac{1}{280000}$ of an inch thick, appeared of a green colour, from which he concluded that it tranſmits the green rays; and he ſuppoſed that other metals might alſo tranſmit light, if they were ſufficiently thin. But no metal has yet been found ſo malleable as to be reduced to that ſtate of thinneſs to permit light to paſs through it. Silver-leaf, ſo thin as to be only $\frac{1}{100000}$ part of an inch, is quite opaque.

1509 Denſity. 6. The metals are particularly diſtinguiſhed from other ſubſtances by their denſity. Metallic ſubſtances have a greater ſpecific gravity than any other bodies in nature; that is, the quantity of matter contained in a given bulk, is greater in the metals than in other ſubſtances. Even the lighteſt of the metals poſſeſſes a greater denſity than the heavieſt bodies known of any other kind of matter. The particles of which they are compoſed muſt therefore be in cloſer contact than in any other body. To this greater denſity is owing their ſuperior luſtre.

1510 Hardneſs. 7. The metals differ from each other greatly in degrees of hardneſs. In general, metallic ſubſtances are not ſo hard as many other natural bodies. The degree of hardneſs does not depend on the denſity, for the hardeſt metals are by no means the heavieſt. This property, therefore, muſt be owing to the nature of the particles of which the metal is compoſed, or to ſome peculiar diſpoſition or arrangement of theſe particles. It is found that ſome of the metals can be hardened by art, merely by hammering, or by ſudden cooling after being heated. The hardneſs of metals, too, is greatly increaſed by being combined with each other, or with other ſubſtances; as, for inſtance, when copper and tin are combined together, or iron and carbone in the formation of ſteel, the utility of which latter, as it is applied for cutting inſtruments, depends on its hardneſs. Metallic ſubſtances, in comparing their different degrees of hardneſs, have been divided into eight claſſes, which are arranged in the following order.

1ſt, Iron and manganeſe.
2d, Platina and nickel.
3d, Copper and biſmuth.
4th, Silver.
5th, Gold, zinc, and tungſten.
6th, Tin and cobalt.
7th, Lead and antimony.
8th, Arſenic.

Mercury being always fluid at the ordinary temperature of the atmoſphere, cannot be compared with regard to this property; and the degree of hardneſs which ſome of the other metals poſſeſs has not been aſcertained.

1511 Elaſticity. 8. The elaſticity of metals ſeems to follow the ſame order in which they poſſeſs the property of hardneſs. The elaſticity of ſome metals can be increaſed in the ſame way as their hardneſs, either by mechanical means, as by hammering, or by new combinations.

1512 Ductility. 9. One of the moſt important phyſical properties of the metals, is ductility. By this is meant that peculiar property which ſome metals poſſeſs, of being drawn out into wire, without deſtroying or diminiſhing the coheſive power of their particles. Some metals poſſeſs this property in a great degree, while others are entirely deprived of it; and ſome metals are extremely ductile, while they poſſeſs in a very ſmall degree another property, namely malleability. Iron is one of the moſt ductile metals, but is much leſs malleable than many others.

1513 Malleability. 10. Malleability is alſo one of the moſt valuable properties of metallic ſubſtances. By this property they can be reduced to any form or ſhape which may be wanted, for thoſe purpoſes to which they are to be applied. This property of malleability is ſuppoſed to depend on the form of the particles, or on the mode of their aggregation. Thoſe metals which poſſeſs this property of malleability or laminability, ſeem to be compoſed of ſmall plates, while the ductile metals ſeem to have their particles arranged in a fibrous form. When metallic ſubſtances are hammered, they become harder, denſer, and more elaſtic, which is owing to their particles being brought into cloſer contact.

1514 Tenacity. 11. Tenacity is expreſſive of the power of coheſion between the particles of metallic ſubſtances. Different metals poſſeſs this property in very different degrees. The method which has been adopted to eſtimate the different degrees of tenacity, is by ſuſpending wires of the ſame diameter of the different metals by one extremity, and attaching weights to the other, till the wires are broken. Iron, which has the greateſt tenacity of all the metals, when formed into wire, $\frac{1}{10}$ of an inch in diameter, will ſupport a weight of 500lb. without breaking, while a wire of lead of the ſame diameter, can only ſupport about 29lbs. The following is the order of the ductile metals, according to the degree of their tenacity.

Iron,
Copper,
Platina,
Silver,
Gold,
Tin,
Lead.

1515 Fuſibility. 12. Another property of the metals is fuſibility. When they are expoſed to a ſufficient degree of heat, they melt, and are reduced to the ſtate of liquidity. One of the metals, namely mercury, is always in the fluid ſtate, at the ordinary temperature of the atmoſphere. The different metals which are generally in the ſolid ſtate, require very different temperatures for their fuſion. Thus lead and tin require comparatively a lower temperature to be melted; while gold and platina can only be brought to the ſtate of fuſion, by the greateſt degree of heat that can be applied.

1516 Conductors of caloric and electricity. 13. Metallic ſubſtances are the beſt conductors of caloric, but the comparative degrees of this property have not been aſcertained. They are alſo found to be the beſt conductors of electricity.

14. The metals poſſeſs ſome properties in common with other ſubſtances, as taſte and ſmell, by which ſome of them are peculiarly diſtinguiſhed; and in being ſuſceptible of cryſtallization, which is the caſe with ſome, or of being volatilized, as happens to others.

1517 Oxidation in the air. 15. But metallic ſubſtances are not only of vaſt importance in the arts of civilized life, on account of the properties which we have now detailed, which belong to them in the metallic ſtate; but many of them are not leſs valuable in thoſe changes which they undergo by new combinations, and the new properties they acquire, in conſequence of theſe changes. One of the firſt and moſt ordinary changes to which metallic ſubſtances are ſubject, is their combination with oxygen. This is called in chemical language *oxidation*. When a metal, as, for inſtance, a piece of iron, is expoſed to the air, when it is moiſt, it ſoon undergoes a remarkable change. It loſes its metallic luſtre, and the ſurface is covered with a browniſh powder, well known by the name of *ruſt*. This change is owing to the combination of oxygen with the metal, and the ruſt of the metal in this ſtate is known in chemiſtry by the name of *oxide*. The proceſs by which this compound of oxygen and a metallic ſubſtance is formed, is called *oxidation*, and the product is denominated an *oxide*.

1518 By heat. 16. But this proceſs of oxidation is effected more rapidly when metals are expoſed to the action of heat; and indeed many metals require a very high temperature to produce the combination, while it cannot be accompliſhed in others by the greateſt degree of heat that can be produced. This proceſs was formerly called *calcination*, or calcining the metal; and the product, now denominated an *oxide*, was diſtinguiſhed by the name of *calx* or *calces*, from its being reduced to the ſtate of powder, in the ſame way as limeſtone, by burning.

1519 Are oxidated in different circumſtances. 17. Metals differ very much from each other in the circumſtances in which this oxidation takes place, in the temperature which is neceſſary, the facility of the combination, the proportions of oxygen which combine, and the force of affinity between the conſtituent parts of the oxide. Some metals are oxidated in the loweſt temperature, as, for inſtance, iron and manganeſe; while others require the greateſt degree of heat that can be applied. Such are ſilver, gold, and platina.

1520 In the air. 18. The facility with which oxidation takes place in ſome metals is ſo great, ſuch as iron, tin, lead, copper, and manganeſe, that they muſt be completely defended from the action of oxygen; but in gold and platina, no perceptible change is obſerved, for whatever length of time they are expoſed to the atmoſphere.

1521 Proportion of oxygen determinate. 19. This oxidation and the quantity of oxygen abſorbed is proportional to the temperature. There are, however, many metals which combine with a determinate proportion of oxygen at certain temperatures, and from this may be eſtimated the quantity of oxidation from the degree of heat which has been applied. The rapidity of the oxidation is almoſt always increaſed by the elevation of temperature. In this way actual combuſtion or inflammation is produced. Thus filings of metals thrown upon a body in the ſtate of ignition, give out brilliant ſparks; and ſteel, ſtruck upon a flint, burns with a vivid flame in the air, in conſequence of the great heat which is communicated to it by percuſſion.

20. Metallic ſubſtances combine with very different proportions of oxygen; and this quantity varies according to the manner in which the proceſs has been conducted, or the temperature to which the metal has been expoſed.

1522 Different phenomena of oxidation. 21. In theſe different ſtates and conditions of oxidation, different phenomena are exhibited. Sometimes the metal becomes red-hot and is inflamed; ſometimes the oxidation takes place without fuſion, or does not combine with oxygen till after it has been melted; ſometimes it is covered with a brittle cruſt, or with a ſubſtance in the form of powder. At other times a pellicle, exhibiting different colours, forms on the ſurface; but, in all caſes, the metal is tarniſhed, loſes its brilliancy and its colour, and aſſumes another, which announces the change that has taken place.

1523 Different affinities. 22. Another difference which takes place among metals, is the different degrees of force with which the oxygen adheres to the metal. The knowledge of this, and the different degrees of affinity between oxygen and metallic ſubſtances, is of great importance in many operations and chemical reſults.

1524 Caloric given out during oxidation. 23. During the fixation of oxygen in metallic ſubſtances, it is abſorbed by ſome in its ſolid ſtate, and gives out a great deal of caloric. In others it is combined, without giving out the ſame quantity. This proportion of caloric given out correſponds to the facility with which oxides part with their oxygen, or are reduced to the metallic ſtate. Thoſe which have combined with oxygen with the greater proportion of caloric, are moſt eaſily reduced; but thoſe, on the contrary, in which the oxygen has been deprived of its caloric, are reduced to the metallic ſtate by a great addition of caloric, and the greateſt number of oxides require the addition of ſubſtances whoſe affinity for oxygen is greater than that of the metal.

1525 Different oxides.

24. Metallic oxides are extremely different in different metals, and even in the ſame metal, according to the proportion of oxygen. They are, however, poſſeſſed of ſome common properties. They are all in the form of powder or earthy ſubſtance, or ſo brittle as to be eaſily reduced to this ſtate. They exhibit every ſhade of colour from pure white to brown and deep red, and they are heavier than the metals from which they have been obtained. Some oxides are revived, as it is called, or are reduced to the metallic ſtate, merely by being in contact with light or caloric. Some require the addition of a combuſtible ſubſtance and a high temperature; while others have ſo ſtrong an affinity for oxygen, that they cannot be deprived of it by the ſtrongeſt heat, but become fuſible in the fire, and afford a glaſſy matter more or leſs coloured, and even ſerve as a flux to the earths. Some oxides are volatile, but the greateſt number are fixed. Some have an acrid and cauſtic taſte, are more or leſs ſoluble in water, and even poſſeſs an acid quality; others are inſoluble and inſipid.

1526 Theory of Stahl.

25. Obſerving this remarkable change produced on metallic ſubſtances by the action of air or of heat, philoſophers began early to account for it. According to Beccher and Stahl, the founders of chemical ſcience, metals are compoſed of earth and phlogiſton, and the proceſs which takes place during the calcination of a metal, is merely depriving it of its phlogiſton. This doctrine, which had undergone various modifications, from the difficulties which it preſented in accounting for the phenomena of the calcination of metals, was finally overthrown by the celebrated experiments of Lavoiſier. In one of theſe experiments he introduced eight ounces of tin into a glaſs retort, and having hermetically ſealed it, after previous heating to expel ſome of the air, it was accurately weighed, and expoſed to heat. The tin melted; and a pellicle appeared on its ſurface, which was ſoon converted into a gray powder. The heat was continued for three hours, but no farther change appeared upon the metal. When the retort was cooled, it was found to have the ſame weight as before the operation. The point of the retort was then broken off, and a quantity of air ruſhed in. This was equal to 10 grs. which was the additional weight acquired by the retort. The whole of the metallic ſubſtance in the retort was 10 grains heavier than when it was introduced, ſo that he concluded, that the 10 grains of air which had diſappeared, had combined with the metal, and cauſed its increaſe of weight. The inference which he drew from this was, that the calcination of metals is not owing to their being deprived of any ſubſtance, but to their combination with air, and with the oxygen of the air; for it was found by future experiments, that the calcination or oxidation of metals could not be effected without oxygen; and when it took place in a given quantity of common air, it was only the oxygen which was abſorbed.

1527 Overturned.

26. But as a ſtill farther proof, that the calcination of metals is owing to the abſorption of oxygen, they are reduced by thoſe ſubſtances which have a greater affinity for oxygen. If charcoal in powder be mixed with a metallic calx or oxide, the oxygen combines with the carbone of the charcoal, forming carbonic acid, and the oxide is reſtored to the metallic ſtate. If this proceſs be performed in cloſe veſſels, the quantity of oxygen in the carbonic acid, correſponds to the quantity which was abſorbed by the metal during calcination.

1528 Metals combine with carbone, &c.

27. From theſe obſervations, therefore, it appears that metallic ſubſtances combine with oxygen; and it has been obſerved, that not only different metals combine with it in different proportions, but the ſame metal forms compounds of one, two, and ſometimes three different portions. No combination takes place between azote or hydrogen and metallic ſubſtances; but ſome of them enter into combination with carbone, phoſphorus, and ſulphur, forming carburets, phoſphurets, and ſulphurets. The metals alſo combine with the acids, and form ſalts, ſome of which are of the utmoſt importance, not only in chemiſtry, but alſo in the arts of life. They alſo enter into combination with each other, forming a claſs of bodies which are diſtinguiſhed by the name of *alloys*.

1529 Diviſion

28. Metallic ſubſtances were formerly divided into *noble* or *perfect*, and *imperfect metals*. The noble or perfect metals were platina, gold, ſilver, mercury; and the property on which this character was founded, was that of their being ſuſceptible of being reduced by being expoſed to heat. The other metals then known, were called *imperfect metals*, becauſe, to reduce them to the metallic ſtate, the addition of ſome combuſtible ſubſtance was found to be neceſſary. They were alſo divided into *metals* and *ſemimetals*. Among the firſt were included thoſe metals, which were malleable and ductile; the ſemimetals comprehended thoſe which poſſeſſed neither of theſe properties, and were therefore conſidered as leſs perfect. Theſe diſtinctions, however, are now neglected, becauſe they afford no well-founded or juſt marks of diſcrimination.

29. In the arrangement of the metals which we propoſe to follow, that of Fourcroy is adopted. He has divided them into five different claſſes, according to their ductility, and the proportions of oxygen with which they combine, or the facility with which that combination takes place. In the firſt claſs he includes thoſe metals which are brittle, and in ſome of their combinations with oxygen have acid properties. Theſe are,

Arſenic,
Tungſten,
Molybdena,
Chromium,
Columbium.

The ſecond claſs comprehends thoſe which are brittle, and ſimply ſuſceptible of oxidation. Theſe are the following:

Titanium,
Uranium,
Cobalt,
Nickel,
Mangeneſe,
Biſmuth,
Antimony,
Tellurium.

The third claſs comprehends thoſe metals which have ſome degree of ductility, which are only two in number, viz.

Mercury,
Zinc.

The fourth claſs, which conſiſts of three metals, includes ſuch as are ductile, and eaſily oxidated. Theſe are,

Lead,
Iron,
Copper.

The fifth claſs is compoſed of three metals, which are characterized by being very ductile, but oxidated with great difficulty. Theſe are,

Silver,
Gold,
Platina.

1530 Natural hiſtory. 30. To theſe preliminary obſervations we have only to add, that metallic ſubſtances are found, either on the ſurface or in the interior of the globe, and either uncombined, or forming compounds with different ſubſtances. Some metals, as gold and platina, are generally found in ſmall grains, mixed with the ſoil. Theſe, as well as the matters with which they are accompanied, have proceeded from the decompoſition of the more ſolid parts of the globe. But metallic ſubſtances, which are met with in greater abundance, exiſt in the interior of the globe, in veins which traverſe the other ſtrata of the earth in different directions. The metals moſt commonly found in veins are, lead, copper, ſilver, zinc, mercury, and antimony. Some exiſt in detached maſſes.

31. Metals, as they exiſt in the earth, are either in a ſtate of purity, or the metallic ſtate, when they are called *native* or *virgin metals*; or combined with each other, when they are ſaid to be *alloyed*. They are found alſo combined with other ſubſtances, very frequently with ſulphur; when they are ſaid to be mineralized: or, they are combined with oxygen, when they come under the denomination of *oxides*; or they are combined with acids in the ſtate of *ſalts*.

Sect. I. *Of Arsenic and its Combinations.*

1531 Hiſtory. 1. It would appear that the ancients were acquainted with arſenic in its ſtate of combination with ſulphur, which is a reddiſh-coloured mineral, and was employed by them in painting; and although Theophraſtus arranged it among metallic ſtones, probably on account of its weight, it was not known to poſſeſs a metallic ſubſtance till the middle of the 17th century. Paracelſus, indeed, who lived at an earlier period, is ſaid to have known it in the metallic ſtate; but the proceſs of obtaining it from orpiment and arſenic, was only firſt deſcribed by Schroeder in 1649. Lemery alſo publiſhed a proceſs for extracting this metal in 1675. It was afterwards fully demonſtrated by Brandt in 1733, and by Macquer in 1746, that arſenic poſſeſſed peculiar properties, and is totally diſtinct from all other metals. Theſe facts were farther confirmed by Monnet in 1773, and by Bergman in 1777.

1532 Found native. 2. Arſenic is frequently found native, and is then in dark-coloured maſſes, which have little brilliancy, and exhibit no metallic luſtre, except at the fracture. It is frequently found combined with other metals. In this ſtate it is combined with iron, and is known by the name of *arſenical pyrites*, or *miſpickel*. One of the moſt frequent combinations of arſenic is with ſulphur, of which there are two principal varieties; the one is of a yellow colour, well known under the name of *orpiment*, and the other red, called *realgar*. It is alſo ſometimes found in the ſtate of white oxide, or arſenious acid; but this is a rare occurrence.

1533 Method of analyzing the ores. 3. In whatever ſtate arſenic is found, it can eaſily be detected, by throwing a little of it on burning coals. The white fume which ariſes, and the garlic ſmell which is exhaled, are ſufficiently characteriſtic of this metal. To obtain the metal from its oxide, it may be mixed with three times its weight of black flux. This mixture is put into a crucible, to which another crucible inverted is adapted. They are then to be luted together, to exclude the air. Apply heat to the lower crucible till it becomes red, defending the upper one as much as poſſible from the heat, by means of a plate of iron or copper, through which the lower crucible paſſes. When the apparatus has cooled, a cruſt of metallic arſenic is found in the upper crucible, in the form of cryſtals. This being detached and weighed, ſhows the quantity of pure metal in the mineral which has been tried.

In the humid way, Bergman recommends to treat native arſenic by diſſolving it in four parts of nitro-muriatic acid, concentrating the ſolution by evaporation, and precipitating the muriate of arſenic which is formed, by means of water. If there is any ſilver, it is firſt precipitated in the form of an inſoluble muriate, and iron is ſometimes found in the ſolution precipitated by water.

The ſulphurets of arſenic are to be treated by muriatic acid, adding a ſmall quantity of nitric acid, to ſeparate the ſulphur. The oxide of arſenic may then be precipitated by water. The pure metal may be obtained by immerſing a plate of zinc in the ſolution, having previouſly added a quantity of alcohol.

1534 Properties. 4. Arſenic is in the form of ſmall plates of a blackiſh gray, brilliant, and metallic colour, with conſiderable luſtre where there is a freſh fracture. The ſpecific gravity is 8.31. It is extremely brittle, and is therefore eaſily reduced to powder. It has neither ſmell nor perceptible taſte when it is cold; but when it is heated, and in the ſtate of vapour, it is remarkable for a ſtrong fetid odour of garlic. It ſublimes before it melts, ſo that its fuſing point is not known. It is the moſt volatile of all the metals. When ſlowly ſublimed, it cryſtallizes in the form of regular tetrahedrons, and ſometimes in that of octahedrons. The tetrahedron is the form of its integrant molecule.

1535 Action of air. 5. When arſenic recently prepared is expoſed to the air, it is ſoon tarniſhed, loſes its luſtre, becomes at firſt yellowiſh, and then paſſes to a black colour. It loſes at the ſame time its hardneſs, and becomes extremely friable. When it is heated in contact with air, or if it be thrown in the ſtate of powder on burning coals, it burns with a blue flame, and exhaling the ſtrong odour of garlic, is ſublimed in the form of a white, acrid, ſoluble maſs, which has been called the *white oxide of arſenic*, or *white arſenic*. By this latter name it is well known in the ſhops. To this oxide of arſenic, becauſe it poſſeſſes ſome acid properties, Fourcroy has given the name of *arſenious acid*. This acid bears the ſame relation to arſenic acid as the phoſphorous and ſulphurous acids do to phoſphoric and ſulphuric acids.

1536 Oxide or arſenious acid.

1537 Properties.

6. This oxide or acid is extremely volatile. When it is heated in cloſe veſſels, it is ſublimed in tranſparent, regular tetrahedrons. It is extremely acrid and cauſtic, corroding and deſtroying the organs of animals, ſo that it is the moſt violent poiſon known. The ſpecific gravity is between 4 and 5. It reddens vegetable blues, and, when expoſed to the air, it is covered with a ſlight effloreſcence.

7. The arſenious acid is decompoſed by hydrogen, carbone, phoſphorus, and ſulphur. At a red heat, the hydrogen and carbone combine with the oxygen, and reduce it to the metallic ſtate. Phoſphorus and ſulphur are partly converted into phoſphoric and ſulphuric acids, and partly combine with the arſenic, forming a phoſphuret or ſulphuret of arſenic.

8. This acid is very ſoluble in water. It requires about 15 parts of boiling water for its ſolution, from which it may be obtained cryſtallized on cooling, or by ſlow evaporation. The cryſtals are in the form of regular tetrahedrons. The ſolution in water is extremely acrid, reddens vegetable blues, combines with earthy baſes, decompoſes the alkaline ſulphurets, and affords with them a yellow precipitate in which the arſenic returns to the metallic ſtate. The component parts of arſenious acid are,

Arſenic	75.2
Oxygen	24.8
	100.0

1538 Arſenic acid.

9. Arſenic combines with a greater proportion of oxygen; and in this compound it ſtill exhibits acid properties, and is known by the name of *arſenic acid*. The method of preparing this acid and its properties have already been deſcribed, in the chapter on acids; and the compounds it forms with the alkalies and earths, have been particularly detailed in the chapters which treat of theſe ſubſtances.

10. Arſenic does not decompoſe water. It may be kept for any length of time under water, without undergoing any change. There is no action between arſenic and carbone or azote. Arſenic, however, is ſoluble in hydrogen gas, to which it communicates a fetid odour and a poiſonous property.

1539 Phoſphuret.

11. Arſenic enters into combination with phoſphorus. When equal parts of phoſphorus and arſenic are diſtilled together with a moderate heat, there is ſublimed a dark-coloured brilliant ſubſtance, which burns on red-hot coals, with a mixed odour of arſenic and phoſphorus. This is the phoſphuret of arſenic, which muſt be preſerved under water. This compound may be formed under water at a boiling temperature in a matraſs. As the phoſphorus melts, it combines with the arſenic. The properties of this phoſphuret of arſenic have not been examined.

1540 Sulphuret.

12. Arſenic combines readily with ſulphur, either by fuſion or by ſublimation. The reſult of this combination is a yellow or red maſs. This compound of ſulphur and arſenic, which is a ſulphuret of arſenic, is found native. The red is known by the name of *realgar*, and the yellow by that of *orpiment*.

13. Arſenic enters into combination with the acids, and forms with them peculiar ſalts. It alſo combines with the metals, forming *alloys*. The following is the order of the affinities of arſenic and of its oxide, as they have been arranged by Bergman.

1541 Salts and alloys.

1542 Affinities.

Arsenic.	Oxide of Arsenic.
Nickel,	Lime,
Cobalt,	Muriatic acid,
Copper,	Oxalic,
Iron,	Sulphuric,
Silver,	Nitric,
Tin,	Tartaric,
Gold,	Phoſphoric,
Platina,	Fluoric,
Zinc,	Saclactic,
Antimony,	Succinic,
Sulphur,	Citric,
Phoſphorus.	Lactic,
	Arſenic,
	Acetic,
	Pruſſic.

1543 Uſes.

14. Arſenic, in the metallic ſtate, is ſcarcely applied to any uſe, except for chemical purpoſes. It is ſometimes alloyed with the metals, by which means they acquire new properties. In the ſtate of white oxide, it is much employed in the arts. It has even been exhibited as an internal remedy in the diſeaſes of cancer and intermittent fevers; but in all caſes this terrible poiſon ought to be adminiſtered with the greateſt caution. To counteract the effects of arſenic, when it has been accidentally taken into the ſtomach, one of the beſt antidotes is water impregnated with ſulphurated hydrogen gas, or ſome of the alkaline ſulphurets diſſolved in water *.

I. Salts of Arſenic.

1. Sulphate of Arſenic.

1544 Effect of ſulphuric acid.

Concentrated ſulphuric acid has no action on arſenic in the cold; but when they are boiled together, an efferveſcence takes place, ſulphurous acid gas is diſengaged, the arſenic is oxidated, and falls to the bottom in the ſtate of white powder. According to Fourcroy, this powder retains but a ſmall portion of ſulphuric acid, the whole of which is nearly carried off by waſhing with water; nor are cryſtals obtained from the ſolution. By evaporation the white oxide of arſenic is precipitated, and ſulphuric acid remains pure in the ſolution. There is no action between ſulphurous acid and arſenic.

2. Nitrate of Arſenic.

1545 Of nitric.

Concentrated nitric acid produces a violent action with arſenic. Nitrous gas is diſengaged, and towards the end of the proceſs, azotic gas. The arſenic is converted at firſt into the white oxide, which, with a new addition of acid, paſſes to the ſtate of arſenic acid; and when a great quantity of nitric acid is employed, with the aid of heat, the metal is inſtantly converted into arſenic acid. There remains no oxide in the ſolution, and there is no nitrate of arſenic formed. But, according to Bergman, when the nitric acid is diluted, it diſſolves the oxide, and affords a cryſtallized ſalt like the white oxide.

3. Muriate

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* Fourcroy, v. p. 80.

3. Muriate of Arſenic.

1546 Preparation. 1. Muriatic acid has no action on arſenic in the cold; but when they are boiled together, the ſolution takes place, and there is diſengaged a fetid gas, which ſeems to be arſeniated hydrogen gas. From this it appears, that muriatic acid enables the arſenic to decompoſe water. A little nitric acid added, promotes the ſolution; and this ſolution, heated and concentrated at firſt in cloſe veſſels, is entirely ſublimed in the form of a thick liquid, which was formerly called *butter of arſenic*. This ſalt is decompoſed by water alone, which precipitates the metal. The muriate of arſenic, therefore, can ſcarcely be conſidered as a permanent ſalt *.

1547 Oxymuriatic acid. 2. When arſenic in the ſtate of powder is thrown into oxymuriatic acid gas, it inſtantly catches fire, burns with a very brilliant white flame, and is converted into white oxide. If arſenic be added to liquid oxymuriatic acid, it is converted into arſenic acid, while the acid returns to the ſtate of muriatic acid.

4. Fluate of Arſenic.

Fluoric acid combines with the white oxide of arſenic, and affords ſmall grains, which have a cryſtalline form; but their properties are unknown.

5. Borate of Arſenic.

Boracic acid alſo combines with the white oxide of arſenic, and affords a ſalt which is in the ſtate of white powder, or in the form of ſmall needles. Their properties are alſo unknown.

6. Acetate of Arſenic.

Acetic acid enters into combination with the white oxide of arſenic, and forms cryſtals, which are only known to be difficultly ſoluble in water.

7. Oxalate of Arſenic.

Oxalic acid, combined with arſenic, affords cryſtals in the form of priſms. Similar cryſtals are obtained by the combination of arſenic with the tartaric acid.

8. Benzoate of Arſenic.

Benzoic acid combines with the white oxide of arſenic, and by evaporating the ſolution, plumoſe cryſtals are obtained. This ſalt has an acid and acrid taſte, is ſoluble in water, ſublimes with a moderate heat, but with a ſtronger heat is decompoſed, and is not precipitated from its ſolutions by alkalies.

SECT. II. *Of* TUNGSTEN *and its Combinations.*

1548 Hiſtory. 1. The name of tungſten is derived from a white, tranſparent mineral, which contains this metal in the ſtate of acid united to lime. This mineral was analyzed by Scheele in 1781, and he found that one of its component parts is lime, and the other an earthy-like ſubſtance, to which he gave the name of *tungſtic acid*. His diſcovery was confirmed about the ſame time by Bergman, who conjectured that the baſis of the acid might be a metallic ſubſtance. This conjecture was verified by the experiments of Meſſieurs D'Elhuyart, two Spaniſh chemiſts, who diſcovered the ſame metal in the mineral call *wolfram*, and aſcertained ſome of its metallic properties. It has ſince been farther examined by Vauquelin and Hecht, and by Allen and Aikin of London.

1549 Found native. 2. This metallic ſubſtance has been only found in the ſtate of acid in combination with lime, iron, mangneſe and lead. When it is combined with lime, it is the tungſten of the Swedes, and in combination with iron it is called wolfram.

1550 Method of obtaining it. 3. To obtain this metal from the acid, it is mixed with charcoal in a crucible, and expoſed to a very ſtrong heat. By this proceſs the metal was obtained in the form of a ſmall button at the bottom of the crucible, in the firſt experiments which were made upon it by the German chemiſts. This crumbled to pieces between the fingers; and when it was examined with a magnifying glaſs, it was found to conſiſt of a number of metallic globules, none of which were larger than a pin head.

1551 Properties. 4. The colour of the metal is a ſteel gray. The ſpecific gravity is 17.6, or, according to others 17.22. It is one of the hardeſt of the metals. It is alſo one of the moſt infuſible, requiring a temperature of 170° Wedgwood. It cryſtallizes on cooling.

1552 Action of heat. 5. When it is heated in the open air, it is readily converted into a yellow oxide, which afterwards, by a ſtronger heat, becomes of a black colour, and then by combining with a greater proportion of oxygen, it aſſumes the character of an acid, namely the tungſtic acid, whoſe properties and combinations with alkalies and earths, have been already deſcribed.

1553 Of phoſphorus, &c. 6. There is no action between tungſten and azote, hydrogen or carbone. Tungſten combines with phoſphorus, forming a phoſphuret, the properties of which are unknown. It alſo combines with ſulphur, forming a ſulphuret of a bluiſh black colour, and which may be cryſtallized. There is no action between this metal and ſulphuric, nitric, or muriatic acids. It is only acted on by nitro-muriatic acid at a boiling temperature, and nitrous gas is diſengaged. Nothing therefore is known of the combinations of tungſten with the other acids.

1554 Alloys. 7. This metal combines with the other metals, and forms alloys with them.

8. It is too little known, and has been produced in too ſmall quantity, to be able to aſcertain any thing of its uſes or application.

SECT. III. *Of* MOLYBDENA *and its Combinations.*

1555 Hiſtory. 1. The mineral called *molybdena*, from which this metal is extracted, was analyzed by Scheele in 1778. He found that it contained ſulphur, and a ſubſtance which he diſcovered to be poſſeſſed of acid properties. Previous to this time, this mineral had been confounded with plumbago or black lead, which it reſembles in appearance. The acid which Scheele obtained from this ſubſtance, Bergman conjectured was a metallic oxide. Theſe experiments were repeated by Pelletier; and he proved that molybdena was a peculiar metal combined with ſulphur, and that in all the different proceſſes the ſulphur was ſeparated, and the metal oxidated. The metal has ſince been called *molybdena*, and the mineral from which it is obtained *ſulphuret of molybdena*.

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* Fourcroy v. p. 73.

1556 Characters of the ore. 2. Molybdena has never been found, exiſting in any other but in the ſtate of ſulphuret, or in that of oxide. The ſulphuret of molybdena, it has been obſerved, was long confounded with plumbago, or the carburet of iron. It has, however, a leſs greaſy feel, more brilliancy, and inclining more to a blue colour. It ſtains the fingers leſs than carburet of iron, and leaves a bluiſh trace on paper. It is difficult to reduce it to powder, on account of the elaſticity of the plates or ſcales of which it is compoſed. The ſulphuret of molybdena, too, becomes electric by friction. When the ſulphuret of molybdena is treated with the blow-pipe, it exhales ſulphur, which is detected by its odour, and a white vapour which is condenſed on cold bodies in the form of plates or cryſtallized needles, of a yellowiſh colour, but which become blue by the contact of the interior flame. 1557 Properties of the metal. Molybdena has only been obtained in black, friable, agglutinated maſſes, which have ſome metallic brilliancy; and when broken, exhibit ſmall round grains, of a grayiſh brilliant appearance. The ſpecific gravity is about 7, and it is extremely infuſible; but ſince the experiments of Dr Hielm, which were made in 1781, this metal has been procured in ſuch ſmall quantity, that its characteriſtic metallic properties have not been aſcertained.

1558 Action of heat. 3. When molybdena is expoſed to a high temperature in contact with air, it is converted into a white oxide, which ſublimes and cryſtallizes in the form of brilliant needles. This oxide has acid properties. When it is heated with combuſtible bodies, it aſſumes a bluiſh colour, with little brilliancy, as it approaches to the metallic ſtate. According to Mr Hatchet, who made a ſet of experiments on the compound of this acid with lead, the molybdate of lead, molybdena, when it is not in the metallic ſtate, appears to ſuffer four degrees of oxigenation. The firſt is the black oxide, which contains the ſmalleſt proportion of oxygen. 1559 Oxides. This oxide is obtained by expoſing to heat in a crucible, a mixture of molybdic acid and charcoal in powder. A black maſs remains, which is the oxide. The ſecond is the blue oxide, which may be obtained by the ſame proceſs, but it muſt not be continued ſo long. The third is the green oxide, which ſeems to be intermediate between an oxide and acid. 1560 Acids. Mr Hatchet propoſes to call it *molybdous acid.* The fourth degree of oxidation is the molybdic acid itſelf, which has at firſt a white colour; but when it is fuſed and ſublimed, is converted into a yellow colour. The properties of this acid and ſome of its combinations have been already deſcribed *.

1561 Action of phoſphorus. 4. Molybdena combines with phoſphorus; but the properties of this phoſphuret are not known. It alſo combines readily with ſulphur, and returns to the ſtate of ſulphuret of molybdena, in which it has only been found native.

1562 Of acids. 5. Molybdena enters into combination with the acids, forming with them peculiar ſalts.

1563 Of alkalies. 6. The alkalies have the property of diſſolving molybdena, and of promoting its oxidation. With the aſſiſtance of heat the alkalies form with the ſulphuret of molybdena, an alkaline ſulphuret which holds the metal in ſolution.

1564 Alloys. 7. Molybdena enters into combination with the metals, and forms alloys with them.

I. Salts of Molybdena.

1. Sulphate of Molybdena.

Sulphuric acid, with the aſſiſtance of heat, diſſolves molybdic acid, and affords a colourleſs ſolution; but when it is cold, it becomes of a deep blue. But neither this nor any other of the ſalts of molybdena ſeem diſpoſed to cryſtallize.

2. Nitrate of Molybdena.

Nitric acid converts the oxides of molybdena into molybdic acid, by giving up its oxygen.

3. Muriate of Molybdena.

Muriatic acid, when boiled with the oxide of molybdena, affords a ſolution of a deep blue colour, and there is formed a blue precipitate.

4. Fluate of Molybdena.

Fluoric acid forms a compound with the oxides of molybdena. The ſolution is of a greeniſh yellow colour, when it is hot; but when it is evaporated to dryneſs, it becomes of a greeniſh blue.

5. Phoſphate of Molybdena.

The oxide of molybdena is diſſolved by phoſphoric acid, with the aſſiſtance of heat, and a ſolution of a blue colour is obtained.

6. Acetate of Molybdena.
7. Oxalate of Molybdena.
8. Tartrate of Molybdena.
9. Benzoate of Molybdena.

All theſe ſalts in ſolution are of a blue colour, and when evaporated to dryneſs, afford a blue powder. They are formed by digeſting the ſeveral acids with the oxides of molybdena.

SECT. IV. *Of CHROMIUM and its Combinations.*

1565 Hiſtory. 1. This metal was diſcovered by Vauquelin in 1797, in a mineral called the *red lead ore of Siberia.* This ore had been formerly analyzed by ſeveral chemiſts, and even by Vauquelin himſelf; but their reſults of the nature of its compoſition only agreed, that lead was one of its conſtituent parts. Vauquelin by his laſt analyſis found that it contained lead, combined with the new acid, of which the baſis is a metal.

1566 Analyſis of the ore. 2. The proceſs which he followed was the following: He boiled one part of the red lead-ore of Siberia with two of carbonate of potaſh, in 200 parts of water. The potaſh combined with the new acid, while the carbonic acid united to the lead. The carbonate of lead precipitated to the bottom in the form of a white powder, and the new ſalt remained in ſolution. By adding nitric acid, the new ſalt was decompoſed, the acid combining with the potaſh. This mineral is completely diſſolved in muriatic acid. The ſolution aſſumes a deep green colour, and by evaporation affords muriate of lead. The fine green colour is owing to the oxide of the new metal having been deprived of part of its oxygen by the muriatic acid, and being thus converted from an orange red to a green.

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* Phil. Tranſ. 1796. p. 336.

1567 Reaſon of the name of the metal.

3. The acid which is obtained by the firſt proceſs, and the oxide by the ſecond, being ſtrongly heated with charcoal in a crucible, afforded a metal different from any other formerly known. To this metal the name of *chromium* was given, from the Greek word χρωμα, on account of the remarkable property which it poſſeſſes of communicating colour to all its ſaline combinations.

1568 Properties.

4. The metal which was obtained, is of a grayiſh white colour, very hard and brittle, and extremely difficult of fuſion; but the ſmall quantity which has been hitherto obtained, precludes chemiſts from aſcertaining its properties.

1569 Found in different minerals.

5. This ſubſtance has been found in four different minerals, exiſting in two ſtates; in the ſtate of green oxide, combined with the oxide of lead, and in the ſame ſtate in the emerald; and in the ſtate of acid, combined with the oxide of lead in the red lead-ore of Siberia, and alſo in the ſpinel ruby. It has alſo been diſcovered in the ſtate of chromic acid, combined with iron, forming a chromate of iron. It has alſo been diſcovered in France.

1570 Oxides.

6. Chromium, therefore, combines with oxygen in two different proportions; the green oxide, and the yellow, or the chromic acid. It is this acid which exiſts in the red lead-ore. When it is ſeparated from the lead, it is in the form of powder, of an orange yellow colour, and is ſoluble in water. Its other properties have been already examined. The green oxide is prepared by expoſing the latter to heat in cloſe veſſels. The chromic acid is partially decompoſed; part of the oxygen is driven off, and the green oxide remains behind. Another oxide alſo, it is ſaid, which is intermediate between chromic acid and the green oxide, has been obtained.

1571 Action of acids.

7. Little is known of the action of acids on this metal; but in the few experiments which have been made, it appears, that it undergoes no change by means of ſulphuric and muriatic acids. Nitric acid diſtilled upon it ſeveral times ſucceſſively, changes it into green oxide, and at laſt into chromic acid. The ſame effect is produced more rapidly by means of the nitromuriatic acid.

SECT. V. *Of COLUMBIUM and its Combinations.*

1572 Hiſtory.

1. This metal was diſcovered by Mr Hatchet, in the year 1802, in a mineral which he found in the Britiſh Muſeum. This mineral had been ſent along with ſpecimens of iron ores from Maſſachuſets in America, to Sir Hans Sloane, in whoſe catalogue it is deſcribed as a "very heavy black ſtone, with golden ſtreaks." Theſe ſtreaks, Mr Hatchet obſerves, proved to be yellow mica.

1573 Characters of the ore.

This mineral is externally of a dark-browniſh gray colour; internally the ſame, inclining to iron gray. The longitudinal fracture is imperfectly lamellated; the croſs fracture ſhews a fine grain. The luſtre is vitreous, in ſome parts inclining to the metallic. It is moderately hard, but very brittle. The colour of the powder is dark chocolate brown. The particles are not attracted by the magnet. The ſpecific gravity is 5.918.

1574 Analyſis.

2. In the analyſis of this mineral, Mr Hatchet diſcovered, that it conſiſts of one part of oxide of iron, and three parts of a white-coloured ſubſtance, which exhibited the properties of an acid. This acid, under the name of *columbic acid*, with its combinations with the alkalies and earths, has been already deſcribed. Having found that it poſſeſſed properties different from all other acids, and alſo, that its baſe is metallic, he gave to the metal the name of *columbium*. In the attempts which Mr Hatchet made to reduce it to the metallic ſtate, even when it was expoſed to a very ſtrong heat with charcoal, the oxide was only found in the ſtate of powder, of a black colour. From theſe experiments it appeared, that this metal combines with oxygen in different proportions, and theſe oxides are diſtinguiſhed by different colours.

5. When the white oxide of this metal was added to phoſphoric acid in ſolution, and evaporated to dryneſs, the whole was put into a crucible, lined with charcoal, and expoſed to a ſtrong heat for half an hour. The incloſed matter had aſſumed a dark brown, ſpongy appearance, which had ſome reſemblance to the phoſphuret of titanium.

4. No ſulphuret was obtained when it was mixed and diſtilled with ſulphur.

5. Columbium combines with ſome of the acids, and forms ſalts, although few of theſe have been examined.

I. Salts of Columbium.

1. Sulphate of Columbium.

Boiling ſulphuric acid forms a tranſparent colourleſs ſolution with columbic acid. When water is added to this ſolution, it becomes turbid, aſſuming a milky appearance; and a white precipitate is gradually depoſited, which cracks as it becomes dry upon the filter, and, from white, it changes to a lavender blue colour; and, when completely dry, to a browniſh gray. It is then inſoluble in water, is ſemitranſparent, and breaks with a vitreous fracture. This precipitate obtained from the ſulphuric ſolution, by the addition of water, is a ſulphate of columbium.

2. Nitrate of Columbium.

The oxide of columbium ſeems to be perfectly inſoluble, and remains unchanged in colour, when digeſted in boiling concentrated nitric acid.

3. Muriate of Columbium.

Columbic acid, when recently ſeparated from potaſh, is ſoluble in boiling muriatic acid. This ſolution may be conſiderably diluted with water, without any change being produced. When evaporated to dryneſs, it left a pale-yellow ſubſtance, inſoluble in water, and which is diſſolved with great difficulty, when it is again digeſted with muriatic aaid.

4. Phoſphate of Columbium.

A few drops of phoſphoric acid being added to a part of the ſolution of columbium in concentrated ſulphuric acid, at the end of about 12 hours converted the whole into a white, opaque, ſtiff jelly, which was inſoluble in water. When a ſmall quantity of phoſphoric acid was added to the muriatic ſolution of columbium, in a few hours a white flocculent precipitate was formed * (A).

Sect. VI. *Of Titanium and its Combinations.*

1575 History of its diſcovery.

1. This metal was diſcovered in 1793 by Klaproth. He obtained it from a mineral called *red ſchorl.* In this mineral he found the oxide of a metal different from any other then known. Previous to this time, indeed, the ſame oxide had been diſcovered by Mr Gregor, in a black ſand which is found in Menachan in Cornwall. To this, from the place, he gave the name of *menachine*, but he had not ſucceeded in reducing it to the metallic ſtate. Klaproth afterwards analyzed the *menachanite* of Mr Gregor, and found that it was preciſely the ſame as the oxide of the metal which he diſcovered in red ſchorl. To this metal he gave the name of *titanium.* The experiments of Klaproth were afterwards repeated by Vauquelin and Hecht in 1796. His reſults were confirmed, and they alſo ſucceeded in reducing a ſmall quantity of the oxide to the metallic ſtate.

1576 Natural hiſtory.

2. This metal has been found only in the ſtate of oxide. Red ſchorl conſiſts entirely of this oxide. It has been found in different countries, as in Spain, France, and Hungary. This oxide is diſſeminated in the fine ſpecimens of rock cryſtal, which are brought from Madagaſcar, cryſtallized in long brilliant needles, the form of the primitive cryſtal being a ſix-ſided priſm with two-ſided ſummits; that of the molecule is a triangular priſm, with right-angled iſoſceles baſes. It is of a red colour of different ſhades. It is brittle, but the fragments are ſo hard as to ſcratch glaſs. The ſpecific gravity is from 4.180 to 4.246. The other mineral, to which Klaproth has given the name of *titanite*, is compoſed of oxide of titanium, ſilica and lime, nearly in equal proportions. Its ſpecific gravity is 3.510.

1577 Analyſis of its ore.

3. Titanium was obtained by Vauquelin, by reducing the native red oxide. He mixed together 100 parts of this oxide with 50 of calcined borax, and 50 of charcoal, formed into a paſte with oil; and expoſed the whole to the heat of a forge raiſed to 166° Wedgwood. By this proceſs he obtained a dark-coloured, agglutinated maſs, having a brilliant appearance on the ſurface.

1578 Properties.

4. Titanium obtained in this way is of a reddiſh yellow colour, ſhining and brilliant on the ſurface, and equally brilliant in ſome of its internal cavities. Its other properties, as it has been only procured in very ſmall quantity, have not been determined.

1579 Action of heat.

5. Titanium ſeems to be one of the moſt infuſible metals known. When the red oxide is expoſed to heat in a crucible, it loſes its luſtre. By the action of the blow-pipe it is deprived of its tranſparence, and becomes of a grayiſh white colour. On charcoal it becomes ſtill more opaque, and of a ſlate gray. The artificial carbonate of titanium, expoſed to heat in a crucible, loſes $\frac{25}{100}$ of its weight, becomes yellow, and, as it cools, reſumes its white colour.

1580 Phoſphuret.

6. Titanium enters into combination with phoſphorus, and forms with it a phoſphuret. This was prepared by Mr Chenevix, by expoſing a mixture of phoſphate of titanium, charcoal, and a little borax, in a crucible, to a very ſtrong heat. The phoſphuret which he obtained was in the form of a metallic button, of a pale white colour, brittle and granular, and infuſible by the action of the blow-pipe. Titanium has not been combined with ſulphur.

1581 Affinities.

7. This metal enters into combination with the acids, and forms ſalts with them. The affinities of the oxides of titanium, as they have been aſcertained by Lampadius, are in the following order.

Gallic acid,
Phoſphoric,
Arſenic,
Oxalic,
Sulphuric,
Muriatic,
Nitric,
Acetic †.

1582 Alloys.

8. In the experiments which were made by Vauquelin and Hecht, to combine titanium with other metals, they did not ſucceed with ſilver, copper, lead, or arſenic; but they formed an infuſible alloy with iron, of a gray colour, interſperſed with yellow-coloured, ſhining particles.

I. Salts

* Phil. Tranſ. 1802. p 49.

† Ann. de Chim. xxvi. 91.

(A) Another metal has been more lately announced by Ekeberg, which, in ſome of its properties, ſeems to reſemble columbium. He obtained this metal from two minerals; to one of which he gave the name of *tantalite*, which is of a blackiſh gray colour, with ſome metallic luſtre, and ſome appearance of cryſtallization. This mineral is very hard; the ſpecific gravity is 7.953. When reduced to powder, it is of a browniſh gray colour, and is not attracted by the magnet. To the other mineral he gave the name of *yttrotantalite.* It was found in ſmall inſulated maſſes, in veins of feldſpar, and black mica. The fracture of this mineral is granular, of a gray metallic appearance, and may be ſcratched, although with difficulty, with a knife. It is not attracted by the magnet. The ſpecific gravity is 5.13. From theſe minerals this chemiſt extracted a ſubſtance, which he concluded to be a peculiar metal in the ſtate of oxide, having the appearance of a white powder. The following are the properties which he aſcertained.

1. It is not ſoluble in any of the acids. 2. The alkalies attract and diſſolve a conſiderable quantity of this ſubſtance, which may afterwards be precipitated by means of the acids. 3. The whole oxide of this metal undergoes no change of colour by the action of heat. 4. Its ſpecific gravity when it has been expoſed to a red heat is 6.5. 5. It fuſes with phoſphate of ſoda, and borax, without communicating to them any colour. 6. The oxide of this metal, heated with charcoal powder, is reduced to the metallic ſtate, exhibits a brilliant fracture, of a dark gray colour. 7. It is again converted into a white powder by the action of the acids. The other properties of this ſubſtance have not been detailed *. To this metal Ekeberg has given the name of *tantalium.*

* Ann. de Chim. xliii. p. 276.

I. Salts of Titanium.

1583 Salts.

1. Sulphate of Titanium.

According to the experiments of Klaproth, ſulphuric acid has no action on the native red oxide of titanium from Hungary: but this acid is found to diſſolve the carbonate of titanium with efferveſcence; and when this ſolution is evaporated, the red oxide is converted into a white, opaque, gelatinous maſs. This was the reſult of Klaproth's experiment. In thoſe of Vauquelin and Hecht, ſulphuric acid being boiled with carbonate of titanium, aſſumed a milky appearance, and there were formed white, light flakes, which were diſſolved by a ſtronger heat; the fluid became tranſparent, but did not afford cryſtals.

2. Nitrate of Titanium.

Nitric acid has ſcarcely any perceptible action on titanium, but it combines with the carbonate, and forms a tranſparent ſolution, which aſſumes an oily appearance in the air, and affords tranſparent cryſtals in the form of elongated rhombs, having the oppoſite angles truncated, ſo as to repreſent hexagonal tables. But according to Vauquelin and Hecht, when they heated a mixture of nitric acid with carbonate of titanium, nitrous gas was diſengaged, and the liquid remained milky. Sugar added to the mixture cauſes a precipitate of the oxide, of a whiter colour than the carbonate; and if the nitric acid be employed diluted, the oxide of titanium is diſſolved, but the ſolution becomes turbid by means of heat, and thus the addition of caloric oppoſes the combination of this oxide with nitric acid, by oxidating it in a higher degree than what is ſoluble in this acid.

3. Muriate of Titanium.

The carbonate of titanium is ſoluble in muriatic acid; and according to Klaproth, the ſolution affords a yellowiſh, tranſparent jelly, which contains numerous tranſparent, cubic cryſtals. Vauquelin and Hecht found, that the carbonate of titanium is diſſolved with efferveſcence in concentrated muriatic acid; and the ſolution aſſumes a deep yellow colour, when it is made without the aſſiſtance of heat. When it was heated, it was reduced to a flaky maſs, which was neither rediſſolved by water, nor by new additions of the acid. A ſimilar ſolution which was not heated remained tranſparent; but when this ſolution was expoſed to a temperature of about 170°, it was converted into a yellow, tranſparent jelly, of an acid and very aſtringent taſte, which, by cooling, depoſited a great number of ſmall cryſtals which effloreſced in the air. When this ſolution was boiled, oxymuriatic acid gas was diſengaged, the oxide was precipitated, and is no longer ſoluble in muriatic acid, till it is boiled for a long time with nitric acid; from which it appears, that the oxide of titanium muſt have a great proportion of oxygen, to combine with muriatic acid, and in this ſtate it can only combine with it in the cold, becauſe when it is expoſed to heat, the acid carries off a portion of its oxygen, which renders it inſoluble. The oxide of titanium, ſeparated from muriatic acid by the action of the blow-pipe, aſſumes a beautiful orange-yellow colour.

4. Carbonate of Titanium.

1584 Preparation. One part of the red oxide of titanium, and five parts of carbonate of potaſh, expoſed to a red heat in a crucible, were ſoon fuſed, and formed a ſolid maſs of a whitiſh gray colour, with ſmall needle-form cryſtals on the ſurface. When this was reduced to powder, and waſhed with warm water, there was depoſited a light white powder, which was found to be carbonate of titanium. The arſenic and phoſphoric acids cauſe a white precipitate of the oxide of titanium from its ſolution in acids. A ſimilar precipitate is produced by oxalic and tartaric acids; but it is inſtantly re-diſſolved, and the ſolution recovers its tranſparency.

1585 Salts of titanium decompoſed. The oxide of titanium is precipitated from its ſolution in acids; 1. By carbonate of potaſh, in the form of a white flaky matter, and by ammonia in the ſame way. 2. Pruſſiate of potaſh cauſes a copious precipitate of a mixed colour of green and brown. 3. Infuſion of nut-galls produces a very voluminous precipitate, of a reddiſh brown colour; and if the ſolution be not too much diluted with water, it coagulates like blood. A rod of tin introduced into a ſmall bottle, with a ſolution of this oxide in muriatic acid, cauſed in a few minutes a pale roſe colour, in that part of the ſolution near the rod. This colour ſoon changed to a beautiful ruby. A rod of zinc firſt produced a violet colour, and afterwards that of indigo. 4. Sulphuret of ammonia combined with this ſolution, produced a pale green colour, and a precipitate of a bluiſh green.

SECT. VII. *Of URANIUM and its Combinations.*

1586 Diſcovery. 1. This metal was diſcovered by Klaproth in the year 1789. It was then announced as a metal more difficult to be reduced than mangneſe, externally of a gray colour, and internally of a clear brown, of conſiderable luſtre, and middling hardneſs; that it might be ſcratched and filed, and that its oxide gives a deep orange colour to porcelain.

1587 Natural hiſtory. 2. It has been obtained from three different minerals. The firſt is in the ſtate of ſulphuret, of a blackiſh colour, and of a ſhining fracture, and ſometimes lamellated. This has been called *pitch blende*. The ſpecific gravity is from 6.37 to 7.50. In this ſtate it is ſometimes combined with iron and ſulphurated lead. The uranium is in the metallic ſtate. The ſecond ore from which this metal is obtained, is the native oxide of uranium. It is always in the ſtate of yellow powder, on the ſurface of the ſulphuret. The ſpecific gravity is 3.24. When it is of a pure yellow colour, it is then a pure oxide. The third ore of the metal is the native carbonate of uranium. Of this there are two diſtinct varieties, the one of a pale green, and ſometimes of a ſilvery white colour. This contains but a ſmall quantity of the oxide of copper, and is very rare. The other is of a ſhining deep green, which is the green mica or *glimmer* of mineralogiſts. Klaproth ſuppoſed that it contained an oxide of uranium, mixed with the oxide of copper; but it has been ſince diſcovered to have carbonic acid in its compoſition. It is cryſtallized in ſmall ſquare plates, and ſometimes, though rarely, in complete octahedrons.

1588 Analyſis of the ore. 3. The proceſs by which Klaproth reduced this metal, is the following. He mixed the yellow oxide of uranium, precipitated from its ſolutions by an alkali, with linſeed oil, in the form of a paſte, and this being expoſed to a ſtrong heat, there remained a black powder, which had loſt rather more than one-fourth of its weight. It was then expoſed to the heat of a porcelain furnace, in a cloſe crucible, and the oxide was afterwards found in a coherent maſs, but friable under the fingers, and reduced to a black ſhining powder. It decompoſed nitric acid with efferveſcence. This black powder covered with calcined borax, was for the ſecond time expoſed to a ſtill ſtronger heat, by which a metallic maſs was obtained, conſiſting of very ſmall globules adhering together.

1589 Properties. 4. The colour of uranium is of a dark gray, and internally of a pale brown. It has little brilliancy, on account of the ſpongy maſs, in which ſtate it was obtained. It may be ſcratched with a knife, and is extremely infuſible. The ſpecific gravity is 6.440.

1590 Action of heat. 5. When uranium is expoſed to a red heat in the open air, or when it is acted on by the blowpipe, it undergoes no change. The yellow oxide of uranium does not melt. It acquires a browniſh gray colour when it is long heated in the air, but it has not been aſcertained whether it gains or loſes oxygen.

6. The oxide of uranium is reduced by means of charcoal, when it is expoſed to heat. Little is known of the combination of uranium with phoſphorus; but when the oxide was treated with blood, and a ſtrong heat applied, an acrid bitter maſs was obtained, which was ſuppoſed to owe its fuſibility to the phoſphorus which it contained.

7. Uranium has not been artificially combined with ſulphur, but it is not improbable that ſuch a combination might take place, ſince it is found native in this ſtate. Of the alloys of uranium with other metals nothing is yet known.

1591 Salts.

I. Salts of Uranium.

1. Sulphate of Uranium.

The yellow oxide of uranium is readily diſſolved in diluted ſulphuric acid; and the ſolution affords, by evaporation, a ſalt of a yellow colour, in the form of ſmall priſms. This ſulphate of uranium is different from all other metallic ſalts yet known, in colour, form, and other properties.

2. Nitrate of Uranium.

Nitric acid diſſolves with equal facility the oxide of uranium. The ſolution being ſlowly evaporated, yields large cryſtals in regular hexagonal tables, of a yellowiſh green colour. The cryſtals of nitrate of uranium are the moſt beautiful of all the metallic ſalts.

3. Muriate of Uranium.

Muriatic acid alſo diſſolves the oxide of uranium, and furniſhes ſmall yellowiſh cryſtals, which are deliqueſcent in the air.

4. Fluate of Uranium.

Fluoric acid combines with the oxide of uranium, and forms with it a cryſtallized ſalt, which is not altered by expoſure to the air.

5. Phoſphate of Uranium.

Phoſphoric acid enters into combination with the oxide of uranium, and forms with it yellowiſh white flakes, which are very little ſoluble in water.

6. Arſeniate of Uranium.

Arſenic acid may be combined with uranium, by decompoſing the nitrate by means of an alkali. A precipitate is obtained of a yellowiſh powder, which is the arſeniate of uranium.

7. Molybdate of Uranium.

In the ſame way molybdate of uranium may be obtained by adding a ſolution of molybdate of potaſh to the nitrate of uranium. It is obtained in the form of powder.

8. Acetate of Uranium.

The oxide of uranium is ſoluble in concentrated acetic acid, with the aſſiſtance of heat; and beautiful yellow cryſtals are obtained, in the form of long, ſlender, tranſparent, four-ſided priſms, terminated by four-ſided pyramids.

1592 Decompoſition of the ſalts of uranium. The ſolutions of the oxide of uranium in acids are precipitated by the alkaline ſulphurets, of a browniſh yellow, and their ſurface is covered at the ſame time with a gray metallic pellicle. The fixed alkalies precipitate from their ſolutions an oxide of uranium, of an orange yellow colour; ammonia occaſions a precipitate of a bright yellow; and the alkaline carbonates throw down a carbonate of uranium of a whitiſh yellow, which is rediſſolved in an exceſs of alkali. The infuſion of nut-galls thrown into one of theſe ſolutions, the exceſs of whoſe acid has been taken up by an alkali, produces a chocolate brown precipitate. Zinc, iron, and tin, introduced into theſe ſolutions, produce no change of colour, either in the cold or by heat.

SECT. VIII. *Of COBALT and its Combinations.*

1593 History. 1. The mineral called *cobalt* or *cobolt*, (B) ſeems to have

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(B) The following curious information from Beckmann, with regard to the diſcovery of this mineral will, we doubt not, prove intereſting to the reader. "About the end of the 15th century, cobalt appears to have been dug up in great quantity in the mines on the borders of Saxony and Bohemia, diſcovered not long before that period. As it was not known at firſt to what uſe it could be applied, it was thrown aſide as a uſeleſs mineral. The miners had an averſion to it, not only becauſe it gave them much fruitleſs labour, but becauſe it often proved prejudicial to their health by the arſenical particles with which it was combined; and it appears even that the mineralogical name *cobalt* then firſt took its riſe. At any rate, I have never met with it before the beginning of the ſixteenth century; and Matheſius and Agricola ſeem to have firſt uſed it in their writings. Friſch derives it from have been firſt employed to give a blue colour to glaſs after the middle of the 16th century; but it was not till about the year 1732, that cobalt was diſtinguiſhed as a peculiar metal by Brandt, a Swediſh chemiſt, who extracted it from its ore, and examined ſome of its properties. In 1761 Lehman gave a particular account of the nature and properties of this ſubſtance; but his reſearches were chiefly limited to the mineral in the ſtate of ore. Bergman afterwards examined this metal, and pointed out the difference between it and nickel, manganeſe, and iron. The nature of it has been more lately inveſtigated by Taſſaert and Thenard, and ſome other French chemiſts.

1594 Ores.

2. Cobalt has never been found in nature in a ſtate of purity. It is either alloyed with arſenic, both metals being in the metallic ſtate; or it is combined with ſulphur and arſenic, or in the ſtate of oxide, or forming a ſalt with arſenic acid. 1. In the firſt ſtate, when it is alloyed with arſenic, it is of a gray or whitiſh appearance, with ſome degree of brilliancy. The ſpecific gravity is 7.72. It is ſometimes cryſtallized in cubes, or octahedrons. When ſmall fragments of this mineral are expoſed to the action of the blow-pipe, or even to the flame of a candle, they give out a garlic ſmell. 2. The combination of ſulphur and arſenic with cobalt is denominated *gray cobalt ore*. The ſpecific gravity is from 6.33 to 6.45. The ſtructure is lamellated, and when it is heated, it emits no garlic ſmell. It cryſtallizes in octahedrons, dodecahedrons, and ſome other forms reſembling the ſulphuret of iron, with which it is frequently combined. 3. The third ſpecies of cobalt ore, is the oxide. It is found in black, friable maſſes, or in the ſtate of a black effloreſcence, which ſoils the fingers. This is a pure oxide of cobalt. 4. The fourth ſpecies is the arſeniate of cobalt, which has been diſtinguiſhed by the names of *flowers of cobalt*, *cobalt bloom*. It is of a peach-bloſſom colour, ſometimes in the ſtate of effloreſcence, ſometimes in the form of ſmall needles of a deep colour, which remains even after they are reduced to powder, and ſometimes in four-ſided priſms terminated by two-ſided ſummits. When it is placed on hot coals, it gives out a ſtrong garlic ſmell, loſes its colour, and becomes black.

1595 Analyſis of the ores.

3. To procure the pure metal from the ores of cobalt, the oxide in the ſtate of black powder, after being roaſted, is mixed with three times its own weight of black flux and a little common ſalt, put into a crucible lined with charcoal, and expoſed to a forge heat. When the fuſion is completed, the crucible is to be ſlightly agitated, to collect together the metallic globules into one maſs. Sometimes two metallic buttons are found under the vitreous ſcoriæ. The cobalt occupies the upper part, and the biſmuth being heavieſt, is loweſt. In this ſtate the cobalt is almoſt always combined with a ſmall portion of arſenic, nickel, or iron. But if the cryſtallized gray oxide of cobalt has been employed, the metal is obtained very pure, by the above proceſs; and when the ore is rich, it yields from 60 to 80 per cent.

By a different proceſs, cobalt may be obtained in the metallic ſtate, which conſiſts in treating the ore with nitric acid, which oxidates and diſſolves both the cobalt and the iron. Theſe oxides are precipitated by carbonate of ſoda, and well waſhed with water. They may be ſeparated by means of nitric acid, which diſſolves the oxide of cobalt, without touching that of the iron.

1596 Properties of cobalt.

4. Cobalt is of a gray colour, inclining to red, and of a very fine granulated texture. It is very brittle, ſo that it is eaſily reduced to a fine powder, which is of a gray colour, and with little brilliancy. The ſpecific gravity, according to Bergman, is 7.700; according to others, it is from 7.811 to 8.5384.

1597 Action of heat.

5. Cobalt is one of the moſt infuſible metals, requiring a temperature equal to 130° Wedgwood. It becomes red before it melts. When it is ſlowly cooled, and by pouring out a part of the fluid when it becomes ſolid at the edges, the cavity is found lined with priſmatic cryſtals. The ſame cryſtallization may be effected by inclining the crucible at the moment the ſurface becomes ſolid.

1598 Oxidation.

6. When cobalt is expoſed to a red heat in an open veſſel, it firſt loſes its colour and its brilliancy, becomes of a deep gray colour, and then paſſes to a black, or an intenſe blue. With a ſtill more violent heat, this laſt oxide melts into a bluiſh black glaſs. It appears, from the experiments of Thenard, that cobalt combines with different proportions of oxygen, forming different oxides. When a ſolution of cobalt in acids is precipitated by an alkali, the precipitate which is formed is firſt of a lilach colour; and with an exceſs of baſe it becomes ſucceſſively blue and olive, and at laſt by drying it becomes entirely black. Theſe different changes depend on the different proportions of oxygen with which it combines.

He precipitated a ſolution of cobalt by pure potaſh. The oxide collected on a filter, was blue, and when expoſed to the air it became of an olive colour; and when waſhed with oxymuriatic acid, it changed from green to brown, and from this ſhade to the deepeſt black. The black oxide diſſolved with efferveſcence in muriatic acid; oxymuriatic acid gas was emitted in great abundance,

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from the Bohemian word *kow*, which ſignifies metal; but the conjecture that it was formed from *cobalus*, which was the name of a ſpirit that, according to the ſuperſtitious notions of the times, haunted mines, deſtroyed the labours of the miners, and often gave them a great deal of unneceſſary trouble, is more probable; and there is reaſon to think that the latter is borrowed from the Greek. The miners, perhaps, gave this name to the mineral out of joke, becauſe it thwarted them as much as the ſuppoſed ſpirit, by exciting falſe hopes, and rendering their labour often fruitleſs. It was once cuſtomary, therefore, to introduce into the church ſervice a prayer that God would preſerve miners and their works from *kobolts* and ſpirits."

"Matheſius, in his tenth ſermon, p. 501, where he ſpeaks of the *cadmia foſſilis*, ſays: 'Ye miners call it *kobolt*; the Germans call the black devil and the old devil's whores and hags old and black *kobel*, which by their witchcraft do injury to people and to their cattle.'—Whether the devil, therefore, and his hags gave this name to cobalt, or cobalt gave its name to witches, it is a poiſonous and noxious metal."

abundance, and when the muriatic acid was concentrated, the ſolution was of a green colour, which in the ſpace of 24 hours became purple. When the acid was diluted, it became inſtantly red. The oxide is ſoluble in ſulphuric and nitric acids, and the ſolution is of a red colour, accompanied with the evolution of bubbles, which ſeem to be oxygen gas.

The brown and coloured oxides produce with ſulphuric, nitric, and muriatic acids, ſimilar effects with the black oxide. With muriatic acid they both give out oxymuriatic acid, and form a ſolution of a green colour, which in time paſſes to a purple; or, if the acid be diluted with water, it becomes inſtantly red. The olive-coloured oxide is prepared by pouring potaſh into a ſolution of cobalt. There is formed a blue precipitate, which expoſed to the air becomes green. If this oxide be treated with diluted muriatic acid, oxymuriatic acid is obtained with a ſlight degree of heat, and the ſolution becomes more and more red, as this acid is diſengaged; ſo that the blue oxide combines with the oxygen of the air.

The blue oxide of cobalt, Thenard thinks, is moſt conveniently obtained by calcining the black oxide for half an hour in a cherry-red heat. It aſſumes a blue colour, by being deprived of part of its oxygen. This oxide diſſolves in acids, without the diſengagement of any gas. Its ſolution in concentrated muriatic acid is green, but if the acid be diluted with water, it is red. 1599 Oxides, four. Thenard concludes from his experiments, that there are four different oxides of cobalt; the blue, the olive, the brown, and the black; although he ſuppoſes that the brown may be a mixture of the olive and black oxides [*].

7. There is no action between azote, hydrogen, or carbone, and cobalt.

1600 Phoſphuret. 8. Phoſphorus enters into combination with cobalt, by projecting bits of phoſphorus on ſmall pieces of cobalt, red hot, in a crucible. The metal is inſtantly fuſed, and it abſorbs about $\frac{1}{15}$ of its weight of phoſphorus. A cruſt is formed at the ſame time on the ſurface, of a violet-red colour. This phoſphuret of cobalt has a metallic luſtre, is of a whiter colour than the metal itſelf, and is more brittle. It loſes its brilliancy in the air; and by the action of the blow-pipe, phoſphorus is diſengaged from the metallic globule, and inflames on the ſurface. There remains behind a vitreous globule of a deep blue colour.

1601 Sulphuret. 9. Sulphur combines with difficulty with cobalt, but the compound may be formed by the aid of the alkalies. This metal is ſoluble in the alkaline ſulphurets, and the reſult is a ſulphuret of cobalt, of a yellowiſh white colour, which is only decompoſed by means of the acids.

1602 Salts. 10. Cobalt enters into combination with the acids, and forms ſalts. It forms alloys alſo with moſt of the metals. The order of the affinities of cobalt and its oxides, according to Bergman, is the following:

COBALT.	OXIDE of COBALT.
Iron,	Oxalic acid,
Nickel,	Muriatic,
Arſenic,	Sulphuric,
Copper,	Tartaric,
Gold,	Nitric,
Platina,	Phoſphoric,
Tin,	Fluoric,
Antimony,	Saclactic,
Zinc,	Succinic,
Phoſphorus,	Citric,
Sulphur.	Lactic,
	Acetic,
	Arſenic,
	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Cobalt.

1. Sulphate of Cobalt.

1. Concentrated and boiling ſulphuric acid is decompoſed by cobalt, with the evolution of ſulphurous acid gas. A thick, grayiſh maſs, inclining to red, is formed. Water diſſolves the ſulphate of cobalt, and affords a grayiſh-coloured liquid. 1603 Preparation.

2. The ſulphate of cobalt cryſtallizes in ſmall needles, or in four-ſided rhomboidal priſms, terminated by two-ſided ſummits. It is of a reddiſh colour, and is ſoluble in 24 parts of water. It is decompoſed by heat, and there remains behind the black oxide of cobalt. By the action of the blow-pipe it ſwells up with effervefcence. The alkalies alſo decompoſe it, by precipitating a reddiſh yellow oxide. One hundred parts of cobalt furniſh 140 parts of this precipitate by pure alkalies; but when the precipitation is effected by means of the alkaline carbonates, 160 parts are obtained. 1604 Properties.

2. Nitrate of Cobalt.

1. Nitric acid combines with cobalt, with the aſſiſtance of a moderate heat. Nitrous gas is diſengaged, the metal is oxidated, and is diſſolved in the acid. The ſolution is of a fleſh-red colour, but when it is concentrated, of a brown colour. By evaporation it affords ſmall reddiſh-coloured priſmatic cryſtals, which are deliqueſcent in the air, and which being placed on red-hot burning coals, ſwell up, and are decompoſed, leaving behind a deep red oxide. 1605 Preparation.

2. It is by the precipitation of this ſalt, that the oxide of cobalt is obtained for the purpoſe of enamels, and for giving a colour to porcelain. When the oxide is precipitated by means of an alkali, it is re-diſſolved when the alkali is added in exceſs. 1606 Enamels.

3. Nitrate of Ammonia and Cobalt.

This triple ſalt was formed by Thenard by adding to a ſolution of cobalt in nitric acid, ammonia in exceſs. No precipitate is obtained. This ſolution being filtered and evaporated to dryneſs, and the reſidue being diſſolved in water, and again evaporated, yielded, on cooling, regular cubic cryſtals of a red colour, and of a pungent taſte. They were not changed by expoſure to atmoſpheric air. Being calcined in a crucible, they burned like nitrate of ammonia, with a vivid, yellowiſh white flame. The reſidue was a black ſubſtance, which had all the properties of cobalt. The ſolution of this ſalt in water is not precipitated by any of the alkalies or earths. It is ſtill more readily decompoſed by ſulphurated hydrogen, or the hydroſulphurets. When it is boiled with potaſh, ammonia is diſengaged; the oxide of cobalt is precipitated, and a nitrate of potaſh is formed *.

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[*] Ann. de Chim. xlii. 210—215.

* Ann. de Chim. xlii. 215.

4. Muriate of Cobalt.

1607 Preparation.

1. Muriatic acid has no effect on cobalt in the cold; but a ſmall quantity is diſſolved with the aſſiſtance of heat. But the black oxide of cobalt is readily diſſolved in muriatic acid. The ſolution is accompanied with effervеſcence, and the diſengagement of oxymuriatic acid gas. When this ſolution is concentrated by evaporation, it becomes of a fine green colour, which changes to red when it is diluted with water. By farther evaporation it is cryſtallized, and affords ſmall deliqueſcent cryſtals of muriate of cobalt in the form of needles.

1608 Sympathetic ink.

2. When theſe cryſtals are diſſolved in water, and ſo diluted that the ſolution is nearly colourleſs, characters marked with it on paper diſappear entirely; but when heated, aſſume a fine green colour. This ſolution was one of the firſt known ſympathetic inks. In making experiments with this ſolution, the characters are written on paper, or, that the experiment may be more amuſing, a landſcape is drawn with a pencil, repreſenting the verdure of ſummer on a winter ſcene. Thoſe parts of the picture in which the ſympathetic ink has been uſed, are inviſible in the cold; but when it is moderately heated, they become of a fine green colour, changing from the winter to the ſummer ſcene. When it is removed to the cold, the colour again diſappears, and if too much heat be not applied, the ſame change may be frequently repeated. When too much heated, the blue colour is converted to a brown, which becomes permanent.

1609 Theories.

3. Various theories have been propoſed to account for this remarkable change. According to ſome, it is owing to the moiſture of the atmoſphere being abſorbed that the colour diſappears; and when this is driven off by heat, it is reſtored. But to this opinion it has been objected, that the ſame effect is produced, when paper, on which characters have been written with this ſolution, is entirely excluded from the atmoſphere, by being introduced into cloſe veſſels. According to others, the ſympathetic effect of this ſolution depends on the iron which is combined with the cobalt. Some ſuppoſe that the concentration of the ſolution, which takes place by the action of heat, is the cauſe of the appearance of the colour; and its dilution, by abſorbing moiſture from the atmoſphere, the cauſe of its diſappearance; while others are of opinion that it is partially deprived of its oxygen by being heated, and abſorbs it again in the cold, when the colour vaniſhes.

1610 Another proceſs.

This ſympathetic ink may be eaſily prepared, by diſſolving the zaffre of commerce in nitro-muriatic acid.

5. Fluate of Cobalt.

Fluoric acid diſſolves the oxide of cobalt, and forms with it a yellow-coloured gelatinous ſolution; or, by careful evaporation, it affords cryſtals, which are fluate of cobalt.

6. Borate of Cobalt.

Boracic acid has no action on cobalt; but it combines with the oxide, by mixing a ſolution of nitrate of cobalt with a ſolution of borax.

7. Phoſphate of Cobalt.

Phoſphoric acid diſſolves the oxide of cobalt, and forms with it a reddiſh-coloured turbid ſolution, which affords a precipitate when the acid is ſaturated.

8. Carbonate of Cobalt.

This ſalt is formed by precipitating cobalt from its ſolutions in acids, by means of alkaline carbonates. One hundred parts of cobalt, which afford only 140 of precipitate by means of the pure alkalies, yield 160 parts, when the precipitate is effected by carbonate of ſoda.

9. Arſeniate of Cobalt.

This ſalt is formed by combining the nitrate of cobalt with the arſeniate of potaſh or of ſoda. It is ſometimes found native, and it exhibits the deepeſt and moſt beautiful red of all the ſalts of cobalt.

10. Tungſtate of Cobalt.
11. Molybdate of Cobalt.
12. Chromate of Cobalt.
13. Columbate of Cobalt.
} Unknown.

14. Acetate of Cobalt.

This ſalt is readily formed, by diſſolving the oxide of cobalt in acetic acid. It does not yield cryſtals by evaporating, but is deliqueſcent in the air. It aſſumes a blue colour when it is heated, but is red in the cold, ſo that it forms a ſympathetic ink.

15. Oxalate of Cobalt.

This ſalt may be formed by precipitating the oxide of cobalt from its ſolution in acids, by means of oxalic acid. This precipitate, when it is dried, is in the form of a red powder, which is inſoluble in water, but may be diſſolved in exceſs of oxalic acid, and cryſtallized.

16. Tartrate of Cobalt.

The oxide of cobalt is ſoluble in tartaric acid, and forms a red-coloured ſolution, which affords cryſtals by evaporation.

II. Action of Alkalies, Earths, and Salts.

1. The alkalies have no action whatever on cobalt; but when the oxides are ſuſpended in water, they ſeparate them from other matters. 1611 Alkalies.

2. Some of the earths, but particularly ſilica, enters into combination with the oxide of cobalt and the fixed alkalies, and forms a beautiful blue-coloured glaſs. The quantity of oxide muſt be ſmall, otherwiſe the glaſs will appear nearly black and opaque, on account of the intenſity of the colour. 1612 Earths.

3. Some of the neutral ſalts expoſed to a high temperature along with cobalt burn with a perceptible flame. It is by this means that the oxide is prepared for the purpoſe of enamels and colouring porcelain. 1613 Salts.

The hyperoxymuriate of potaſh, with one-third of its weight of cobalt in powder, detonates by percuſſion.

1614 Uſes. Cobalt is ſcarcely at all employed in the metallic ſtate. *Zaffre* is uſed for coarſe enamels and pottery ware. The purer oxides of cobalt are choſen for the purpoſe of colouring porcelain. *Azure* is a vitreous blue in the ſtate of fine powder, which is prepared for ſimilar purpoſes. Zaffre is fuſed along with ſilica and an alkali, and thus forms a deep blue glaſs, which is known by the name of *ſmalt*. This is reduced to a powder, and mixed with a great quantity of water. The firſt portion which precipitates is called *coarſe azure*. Four different quantities are ſeparated in this way. The laſt, which is the fineſt, is called azure of four fires.

SECT. IX. *Of Nickel and its Combinations.*

1615 Hiſtory. 1. The firſt mention which is made of this metal is by Hierne, a Swediſh chemiſt, in a work entitled *The art of diſcovering metals*, publiſhed in 1694. He particularly deſcribes the mineral from which nickel is extracted, and which was firſt called *kupfernickel*, or *falſe copper*, becauſe it was taken for an ore of copper, and none could be obtained from it. This was the opinion of Henckel and Cramer, who ſuppoſed it to be copper combined with arſenic or cobalt. This mineral was generally arranged among copper ores, till it was examined and analyzed by the celebrated Swediſh mineralogiſt Cronſtedt, in 1751, and 1754. In theſe experiments, the account of which was publiſhed in the memoirs of the Swediſh Academy, he proved that this mineral contains a new metal, different from all thoſe which had been hitherto known, to which he gave the name of *nickel*. This opinion was generally adopted, and objected to only by Monnet and Sage of France, who affirmed that this new metal was merely an alloy of cobalt, arſenic, iron, and copper. To remove theſe differences of opinion with regard to this ſubſtance, Bergman undertook an elaborate analyſis of the ores of nickel, and an accurate examination of its peculiar properties in the metallic ſtate. His experiments were detailed in a diſſertation which was publiſhed in 1755. The object of his reſearches was, to aſcertain if nickel was a peculiar metal; and, from the reſult of his experiments it appeared, that it did not contain the ſmalleſt trace of copper, but that it is generally alloyed with cobalt, arſenic, and iron, from which indeed it can ſcarcely be completely ſeparated; but that it poſſeſſed peculiar and diſtinct properties from the other metals; and theſe properties became more ſtriking and characteriſtic in proportion to its purity.

1616 Ores. 2. Nickel is found in the ſtate of ſulphuret, when it is called *kupfernickel*. It is of a reddiſh yellow colour, with little brilliancy, ſomewhat ſimilar to tarniſhed copper, with which, from its appearance, it is frequently confounded. This mineral ſoon loſes its brilliancy in the air, becomes of a browniſh colour, and is covered at laſt with greeniſh ſpots. It is found forming veins in the earth, and is uſually combined with arſenic, cobalt, and iron. Nickel has been found alloyed with iron, when it is of a laminated texture, and compoſed of rhomboidal plates. The freſh fracture is of a pale yellow, which becomes black by expoſure to the air. Nickel is alſo found native in the ſtate of oxide, when it is of a bright green colour. In this ſtate it is generally on the ſurface of ſulphuret of nickel. Native nickel has alſo been found, according to Bergman, or at leaſt with a very ſmall proportion of ſulphur, but combined with iron, cobalt, and arſenic. He ſays, too, that it exiſts in combination with ſulphuric acid.

1617 Separation of the metal. 3. To obtain nickel from its ores in the ſtate of ſulphuret, they are firſt roaſted, by which means the ſulphur and arſenic are driven off. In this proceſs the mineral loſes one-third or one-half of its weight; and in proportion to the quantity of pure metal, which exiſts in the ore, it aſſumes a richer green. The roaſted ore is then mixed with two parts of black flux, put into a crucible covered with muriate of ſoda, and expoſed to a forge heat, to bring it to fuſion. When the apparatus has cooled, there is found under the brown, black, or blue ſcoriæ, a metallic button, which amounts to one-tenth, and ſometimes to one-half, of the mineral employed.

1618 Properties. 4. Nickel, in the pureſt ſtate in which it can be obtained, is of a yellowiſh white, or of a reddiſh white colour, with more or leſs luſtre, and of a granulated texture. The ſpecific gravity is 9 according to Bergman, but according to Guyton it is only 7.807. Bergman ſpeaks of it as poſſeſſing ſome degree of ductility; but this, it is ſuppoſed, is owing to its alloy with iron, which latter conſtitutes $\frac{1}{5}$ of its weight. It is alſo magnetic, and this property has alſo been ſuppoſed to depend on the ſame alloy. Nickel is a very infuſible metal, requiring a temperature equal to 150° Wedgwood. Its power of conducting caloric has not been aſcertained, nor has its taſte or its ſmell been recognized. It has never been obtained in cryſtals.

1619 Action of heat. 5. When nickel is expoſed to heat in an open veſſel, it combines with oxygen, and aſſumes a brown colour; but this requires a very high temperature. After long expoſure to the air, when it is moiſt, and in the cold, it becomes covered with an effloreſcence of a bright green colour, of a peculiar and diſtinct ſhade. 1620 Oxide. It is this efflorescence which is found on the ſurface of the native ſulphurets of nickel, the ſhade of which is ſo remarkable, and ſo different from that of copper, that they can be eaſily diſtinguiſhed. This oxide is compoſed of

Nickel,	77
Oxygen,	23
	100

6. There is no action between nickel and azote, hydrogen, or carbone; nor is it at all acted upon by water.

1621 Phoſphuret. 7. Nickel combines with phoſphorus, and forms with it a phoſphuret. This is prepared by decompoſing phoſphoric acid in the ſtate of glaſs, which is done by mixing phoſphoric glaſs, charcoal and nickel, and fuſing them together. Or it may be prepared, by projecting bits of phoſphorus on the metal, while it is red-hot, in a crucible. It acquires an addition of one-fifth part to its weight; but it parts with a ſmall portion of phoſphorus as it cools. The phoſphuret of nickel is of a more brilliant and purer white than the metal itſelf. The texture reſembles a collection of ſmall needles heaped together. When it is heated under the blowpipe,

pipe, the phoſphorus burns on its ſurface, and the metal is oxidated. The component parts of this phoſphuret, according to Pelletier, are

1622 Compoſition.

Nickel,	83.3
Phoſphorus,	16.6
	100.0[*]

1623 Sulphuret. 8. Nickel combines readily with ſulphur, and forms with it a ſulphuret, which is ſomewhat different in its properties from the native ſulphûret. It is hard, of a yellowiſh colour, and in ſmall brilliant facets. When it is ſtrongly heated in the open air, it gives out luminous ſparks.

1624 Alloys. 9. Nickel enters into combination with ſeveral of the metals, and forms with them alloys; the properties of which are but little known. With cobalt and arſenic it forms native alloys. The alloy with the latter is of a reddiſh colour, has no magnetic property, is conſiderably hard, and its ſpecific gravity is leſs than the mean ſpecific gravity of the two metals.

1625 Salts. 10. Nickel enters into combination with the acids, and forms with them ſalts, which are diſtinguiſhed by peculiar properties.

1626 Affinities. 11. The order of the affinities of nickel and its oxide, as they have been aſcertained by Bergman, is the following:

NICKEL.	OXIDE of NICKEL.
Iron,	Oxalic acid,
Cobalt,	Muriatic,
Arſenic,	Sulphuric,
Copper,	Tartaric,
Gold,	Nitric,
Tin,	Phoſphoric,
Antimony,	Fluoric,
Platina,	Saclactic,
Biſmuth,	Succinic,
Lead,	Citric,
Silver,	Lactic,
Zinc,	Acetic,
Sulphur,	Arſenic,
Phoſphorus.	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Nickel.

1. Sulphate of Nickel.

1627 Preparation. Concentrated ſulphuric acid, with the aſſiſtance of heat, is decompoſed by nickel. Sulphurous acid gas is diſengaged, and there remains behind a gray maſs ſoluble in water, to which it communicates a beautiful green colour. By evaporating this ſolution, cryſtals of a pale emerald green are obtained, which are ſulphate

1628 Properties. of nickel. The oxide of nickel is alſo readily diſſolved by ſulphuric acid, from which alſo cryſtals are obtained. It cryſtallizes in the form of ſquare priſms, or in decahedrons, which are compoſed of two four-ſided pyramids, truncated at the ſummits.

2. Nitrate of Nickel.

Nitric acid oxidates and diſſolves nickel with the aſſiſtance of heat. The oxide is diſſolved by this acid, without efferveſcence. The ſolution has a blackiſh green colour, which affords rhomboidal, deliqueſcent cryſtals, that are decompoſed by heat, and leave, after being ſtrongly calcined, and giving out oxygen gas, a black oxide. When the nitrate of nickel is expoſed to a warm dry air, it is deprived of its water of cryſtallization, and even of its acid, ſo that there remains behind only an oxide of the metal.

3. Nitrate of Ammonia and Nickel.

This triple ſalt is formed, by adding ammonia in exceſs to the ſolution of nitrate of nickel. This ſalt is of a green colour. It is obtained in cryſtals by evaporation. The ſolution does not become turbid by the addition of alkalies, but the metal is precipitated by hydroſulphurets[*].

4. Muriate of Nickel.

Muriatic acid diſſolves nickel and its oxide ſlowly, except with the aſſiſtance of heat. The ſolution is of a green colour, and affords irregular cryſtals. The muriate of nickel is decompoſed by heat, and by expoſure to the air.

5. Fluate of Nickel.

Fluoric acid diſſolves the oxide of nickel with difficulty, and affords cryſtals of a bright green colour.

6. Borate of Nickel.

The compound of boracic acid and nickel can only be formed by double affinity, by adding the borate of ſoda, for inſtance, to a ſolution of nickel in acids.

7. Phoſphate of Nickel.

Phoſphoric acid has not a very ſtrong affinity for the oxide of nickel. The ſolution which is formed is ſcarcely of a green colour, and does not afford cryſtals.

8. Carbonate of Nickel.

Liquid carbonic acid, expoſed to the contact of nickel, did not appear, to Bergman, to combine with the metal. But when nickel is precipitated from its ſolutions by means of alkaline carbonates, the precipitate acquires a greater weight than when the pure alkali is employed; from which it is concluded, that part of the carbonic acid has combined with the oxide.

9. Arſeniate of Nickel.

Arſenic acid forms with the oxide of nickel a green ſaline maſs, which is obtained by precipitating the oxide of nickel from its ſolution in acids, by means of an alkaline arſeniate. The arſeniate of nickel is in the form of powder, which is ſcarcely ſoluble in water.

10. Tungſtate of Nickel.	Unknown.
11. Molybdate of Nickel.	
12. Chromate of Nickel.	
13. Columbate of Nickel.	

14. Acetate of Nickel.

Acetic acid diſſolves the oxide of nickel, and forms a ſalt in rhomboidal cryſtals, which are of a deep green colour.

15. Oxalate

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[*] Ann. de Chim. xiii. 135.

[*] Ann. de Chim. xlii. 217.

15. Oxalate of Nickel.

With the aſſiſtance of heat, oxalic acid acts upon nickel, and a pale green powder precipitates. This ſalt is ſcarcely ſoluble in water. It may be formed alſo, by precipitating nickel from its ſolutions in ſulphuric, nitric, and muriatic acids, by means of oxalic acid.

16. Tartrate of Nickel.

This ſalt, and the combinations of the oxide of nickel with the other acids, are unknown.

II. Action of Alkalies.

1629 Fixed alkalies. The fixed alkalies diſſolve the oxide of nickel, but in ſmall quantity. They aſſume a yellow colour; 1630 Ammonia. but this oxide is very ſoluble in ammonia; the ſolution of which is of a deep-blue colour, and of a peculiar ſhade. When it is evaporated, it precipitates in the form of a blackiſh brown powder, which paſſes from blue to green. Moſt of the metals ſeparate the nickel from this ſolution.

III. Action of the Earths.

1. Many of the earths, as ſilica and alumina, have no action on nickel; but others, as barytes and ſtrontites, convert the oxide in ſolution into an orange red. If it contain arſenic or cobalt, the glaſs, which is coloured with nickel, becomes of a blue or violet colour.

2. The nitrates and the hyperoxymuriates very readily decompoſe the ſalts of nickel, and reduce it to the ſtate of oxide. With the boracic and phoſphoric ſalts it aſſumes a pale red colour. The nitrate of potaſh detonates feebly with nickel, but has the property of detecting the ſmalleſt trace of cobalt, which could not have been diſcovered by any other reagent.

1631 Uſes. So far as is known, this metal has not been applied to much uſe. There is, however, little doubt, that it might be employed for enamels, and for colouring glaſs, porcelain and pottery. Fourcroy obſerves, that it is probably employed in ſome of the ſecret proceſſes of theſe manufactures, as it is brought in conſiderable quantities from Saxony to Paris.

Sect. X. *Of Manganese and its Combinations.*

1632 Hiſtory. 1. A ſubſtance was long employed in the manufacture of glaſs, which, on account of its property of depriving glaſs of its colour, was known under the name of *glaſsmaker's ſoap*; from its appearance it was called *black magneſia*, or *manganeſe*. But although it was long employed in manufactures, nothing was known of its intimate nature or conſtituent parts. It was generally conſidered as an ore of iron, becauſe it was found ſometimes combined with the oxide of this metal. By others it was arranged among the ores of zinc, ſuppoſing that it was ſome combination of this metal. To Bergman and Scheele we are indebted for the firſt accurate knowledge of its nature. Bergman, in a diſſertation which he publiſhed in 1774, announces it as a peculiar metal, on account of its weight, its property of colouring glaſs, and of affording a white precipitate with the alkaline pruſſiates. Scheele, in the ſame year, preſented to the academy of Stockholm, a memoir, containing his reſearches concerning the nature and peculiar properties of this mineral. From theſe experiments he concludes that this mineral is the oxide of a peculiar metal, totally diſtinct from all others. Gahn, the pupil of Bergman, was the firſt who obtained the metal in its pure ſtate, from the native oxide of manganeſe. His experiments have been repeated by others, and the reſults of Scheele and of Bergman fully confirmed.

1633 Ores. 2. Manganeſe is moſt generally found in the ſtate of oxide. Of this there are three principal varieties, the white, the red, and the black. 1. The firſt, or the white ore of manganeſe, contains the ſmalleſt proportion of iron and of oxygen. Sometimes it is cryſtallized. This ore ſoon tarniſhes in the air by abſorbing oxygen. 2. The red ore of manganeſe contains more iron than the former. It is either friable, or hard as it is found in carbonate of lime, on ſhiſtus, or accompanying ores of iron; or in lamellated maſſes, radiated or cryſtallized in pyramids, rhomboids, or in ſhort brittle needles. 3. The black or the brown ore is frequently cryſtallized like the red. It is alſo found in ſolid maſſes having a metallic or dull earthy appearance, mixed with quartz and other ſtony bodies. The ſpecific gravity is 4.0. Manganeſe has been found native by Lapeyrouſe in ſome iron mines in France. It was in the form of ſmall, flattened metallic buttons, of a lamellated texture. But it has been ſuppoſed that the manganeſe in this ſtate is alloyed with iron.

1634 Separation of the metal. 3. Manganeſe is procured in the metallic ſtate by the following proceſs. The native oxide of manganeſe is reduced to a fine powder, and formed into a paſte with water. Part of it is then made into a ball, and introduced into a crucible lined with charcoal. A thick ſtratum of charcoal is placed at the bottom of the crucible, and the ball of manganeſe is to be ſurrounded and covered with the ſame ſubſtance, and the crucible, which is inverted and luted to the other, is to be filled with it. The whole is then to be expoſed to a very ſtrong heat, not leſs than 160° Wedgwood, for more than an hour. When the apparatus cools, the metal is found in the bottom of the crucible, or in the midſt of the ſcoriæ, in the form of globules, which amount to nearly one-third of the manganeſe employed. But if the heat has been too low it will be found in grains.

1635 Properties. 4. Manganeſe is of a grayiſh white colour, with conſiderable brilliancy, and of a granular texture. The ſpecific gravity is 6.850. It has neither taſte nor ſmell. In hardneſs it is equal to iron. It is one of the moſt brittle of the metals, and at the ſame time one of the moſt infuſible, requiring a temperature of 160° Wedgwood to melt it. When in the ſtate of powder it is often attracted by the magnet, on account of the iron, from which it can only be ſeparated with great difficulty.

1636 Action of air. 5. When this metal is expoſed to the air, it is ſoon tarniſhed. It becomes gray, brown, and black, and at laſt falls down into powder, which is found to have acquired conſiderable addition to its weight. But when it is heated in the open air, it paſſes more rapidly through the different changes of colour, in proportion as it combines with oxygen, to the abſorption of which theſe changes are owing. It appears, therefore, that manganeſe, like ſome of the other metals, combines with different portions of oxygen, forming different oxides. The black oxide, which is manganeſe, combined with oxygen in the greateſt proportion, is found native in great abundance. 1637 Oxides. The red oxide is ſuppoſed to contain the oxygen in the next proportion. This alſo exiſts native, and it may be formed by diſtilling 1638 Black. the black oxide made into a paſte with concentrated ſulphuric acid in a retort to dryneſs. It is deprived of a great quantity of oxygen, which is given out in the ſtate of gas. The reſiduum is then to be mixed with water, which is to be filtered. This ſolution, which is ſulphate of manganeſe, is of a red colour. 1639 Red. By adding an alkali, a precipitate is formed, which is the red oxide of manganeſe. The white oxide is alſo prepared by depriving the black oxide of part of its oxygen. This is effected by pouring nitric acid on the black oxide of manganeſe, with the addition of ſugar, which abſorbs the oxygen and converts it into the white oxide. The latter is then diſſolved in the acid, from which it may be precipitated by potaſh. 1640 White. The precipitate is in the form of a white powder. The proportions of manganeſe and oxygen in the white and brown oxides of manganeſe, according to Bergman, and in the black, according to Fourcroy, are,

	White Oxide.	Brown Oxide.	Black Oxide.
Manganeſe	80	74	60
Oxygen	20	26	40
	100	100	100

When theſe oxides are expoſed to the air, they abſorb oxygen, and are again converted into the black oxide with the greater proportion of oxygen.

1641 Furniſhes oxygen. 6. It is from the black oxide of manganeſe that chemiſts generally procure oxygen gas. The moſt economical proceſs is that which has been already deſcribed in the chapter on oxygen. This is by expoſing it to a red heat in an iron bottle. The manganeſe is reduced to the ſtate of red oxide by being deprived of the difference of the quantity of oxygen between the black and the brown oxides. The ſame manganeſe may be employed after it has been for ſome time expoſed to the air, and occaſionally moiſtened with water. This proceſs, however, goes on much more ſlowly than is generally ſuppoſed. We have kept ſeveral quantities of manganeſe, which had furniſhed abundance of oxygen, and had ceaſed to give out more in a red heat, expoſed to the air for many months, and frequently moiſtened with water, but when it was again heated to redneſs, it did not yield above $\frac{1}{10}$ part of the original quantity from the native manganeſe.

7. Manganeſe does not enter into combination with azote, hydrogen, or carbone. It is by means of charcoal that the oxide of manganeſe is reduced, by being deprived of its oxygen; and what has been ſuppoſed to be a compound of manganeſe and carbone, is a carburet of iron, or carbone combined with the iron, with which manganeſe is almoſt always alloyed.

1642 Phoſphuret. 8. Phoſphorus combines very readily with manganeſe. Pelletier formed the phoſphuret of manganeſe by fuſing a mixture of equal parts of manganeſe, in the metallic ſtate and phoſphoric glaſs, with about $\frac{1}{6}$ part of charcoal in powder; or by fuſing equal parts of the two former without the charcoal; or by projecting ſmall bits of phoſphorus on manganeſe heated to redneſs in a crucible. The phoſphuret obtained by any of theſe proceſſes, is of a white colour, of a granulated texture and brittle, and much diſpoſed to cryſtallize. It undergoes no change by expoſure to the air. It was covered with an opaque, vitreous matter of a yellowiſh colour. It is more fuſible than the manganeſe itſelf. When it is expoſed to the action of the blow-pipe, the phoſphorus burns, and the metal is oxidated *.

1643 Sulphuret. 9. Bergman failed in forming a compound with ſulphur and manganeſe by direct combination. But he ſucceeded in combining ſulphur with oxide of manganeſe. Three parts of ſulphur, and eight parts of the oxide, expoſed to heat in a glaſs retort, formed a greeniſh yellow maſs, which efferveſced with acids, and emitted ſulphurated hydrogen gas. Scheele has obſerved, that a part of the ſulphur is converted into ſulphurous acid during the proceſs.

1644 Affinities. 10. Manganeſe enters into combination with the acids, and forms ſalts with them. The order of the affinities of the oxides of manganeſe for the acids, according to Bergman, is the following:

OXIDE of MANGANESE.

Oxalic acid,
Citric,
Phoſphoric,
Fluoric,
Muriatic,
Sulphuric,
Nitric,
Saclactic,
Succinic,
Tartaric,
Lactic,
Acetic,
Pruſſic,
Carbonic.

I. Salts of Manganeſe.

1. Sulphate of Manganeſe.

1. Concentrated ſulphuric acid acts on manganeſe, even in the cold; but the action is more powerful if the acid be diluted with two or three parts of water. Hydrogen gas is given out, and there remains behind in the liquid, a black, ſpongy maſs, which is the carburet of iron. The ſolution is colourleſs, and it affords by evaporation, tranſparent, colourleſs cryſtals. Sulphuric acid does not combine with the black oxide of manganeſe, till it is deprived of part of its oxygen, and reduced to the ſtate of red or white oxide; but the acid combines with either of the two latter oxides, forming 1645 Two ſulphates. ſalts poſſeſſed of diſtinct properties. There, are therefore, two ſulphates of manganeſe, which may be diſtinguiſhed, from the colour of the baſe or oxide, by the names of white and red ſulphates.

1646 With the white oxide. 2. *White ſulphate of manganeſe.*—This is the compound of ſulphuric acid and the white oxide of manganeſe. This oxide combines with the acid without efferveſcence, and forms a colourleſs ſolution, which yields by evaporation, tranſparent rhomboidal cryſtals, which have a very bitter taſte. This ſalt is decompoſed by heat; the acid is driven off, and oxygen gas is given out. It is decompoſed alſo by the pure alkalies, and a precipitate is formed, of the white oxide of manganeſe, which ſoon becomes brown by expoſure to the air, in conſequence of the abſorption of its oxygen. The alkaline carbonates precipitate a carbonate of manganeſe, which does not abſorb the oxygen from the air, and does not become black like the former. It is the white ſulphate of manganeſe, which is obtained by diſſolving the metal. in diluted ſulphuric acid. In this proceſs the manganeſe combines with the oxygen of the water, which is decompoſed, and is converted into the white oxide, which unites with the ſulphuric acid, to form the ſulphate. The hydrogen of the water is driven off in the ſtate of gas, ſo that the ſalt formed in this way, occaſions an effervеſcence. This ſalt may alſo be formed by diſſolving the black oxide in ſulphuric acid; but in this caſe it is neceſſary, as Scheele diſcovered, to add ſome vegetable matter, as ſugar, honey, or gum, to abſorb the ſuperabundant quantity of oxygen, which prevents the ſolution of the manganeſe in the acid. When, therefore, the black oxide is reduced to the ſtate of white oxide, by depriving it of part of its oxygen, it combines with the acid, and forms white ſulphate of manganeſe, as in the former proceſſes.

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* *Ann. de Chim.* iii. 137.

1647 With the red oxide.

3. *Red Sulphate of Manganeſe.*—If the black oxide of manganeſe be diſtilled to dryneſs with ſulphuric acid, diluted with half its weight of water, and if the reſiduum be waſhed with water, a reddiſh or violet-coloured ſolution, which is the red ſulphate of manganeſe, is obtained. By evaporation it affords thin cryſtalline maſſes, which have no regular form. Theſe are alſo of a reddiſh colour. The alkalies occaſion a red precipitate, which becomes black by expoſure to the air. This ſulphate may be alſo formed by the direct combination of the red oxide with the acid.

Bergman has obſerved, that the red oxide of manganeſe is intermediate between the black and the white; that it is more ſoluble in ſulphuric acid than the former, and leſs ſoluble than the latter; that the red forms a red-coloured ſulphate, while the white affords a colourleſs ſulphate.

4. Sulphurous acid acts feebly or ſcarcely at all on manganeſe; but it diſſolves the black oxide readily, and without effervеſcence. There is not formed, however, a ſulphite of manganeſe; for the ſulphurous acid deprives the black oxide of a portion of its oxygen, and thus converts it into a white oxide, while the acid itſelf is converted into ſulphuric acid. The white oxide is then diſſolved in the ſulphuric acid, and forms the white ſulphate of manganeſe.

2. Nitrate of Manganeſe.

1648 White oxide.

1. Nitric acid diſſolves manganeſe with effervеſcence, and with the evolution of nitrous gas. There remains behind a black, ſpongy maſs, which is carburet of iron, and inſoluble. The ſolution thus formed, is of a dark colour, on account of the iron which it contains; for it does not appear that the red oxide of manganeſe combines with nitric acid. The white oxide of manganeſe diſſolves very readily in nitric acid, and without effervеſcence, or the emiſſion of nitrous gas. This ſolution, if the oxide be pure, is colourleſs. It does not afford cryſtals, even by ſlow evaporation. The black oxide of manganeſe cannot be diſſolved in nitric acid, but by long digeſtion; but by adding ſome vegetable matters, as honey, ſugar, oils, or even ſome of the metals, to deprive the oxide of part of its oxygen, the combination is effected. Carbonic acid gas, which is formed by the union of the carbone of the vegetable matters with the oxygen of the manganeſe, is given out during the proceſs.

2. Nitrous acid diſſolves the oxide of manganeſe much more readily than the nitric acid. No effervеſcence takes place, becauſe the oxygen of the manganeſe combines with the nitrous acid, and forms nitric acid, which latter combines with the oxide of manganeſe, reduced to the ſtate of white oxide; and thus there is formed, not a nitrite, but a nitrate of manganeſe.

3. Muriate of Manganeſe.

1649 White oxide.

1. Manganeſe is diſſolved with effervеſcence, and with the evolution of hydrogen gas, in liquid muriatic acid. The white oxide combines with the acid, without effervеſcence, and without the ſeparation of any gas, becauſe it is ſufficiently oxidated, to be diſſolved in this acid. The black oxide is diſſolved with equal facility in muriatic acid as in the other acids. In this caſe an effervеſcence takes place, with the diſengagement of oxymuriatic acid gas. The nature of this action is obvious. Part of the muriatic acid combines with part of the oxygen of the manganeſe, and forms oxymuriatic acid, which is diſengaged in the ſtate of gas. The black oxide is deprived of part of its oxygen, and converted into the white oxide, which latter diſſolves in the remaining part of the muriatic acid, and forms a muriate of manganeſe. This ſalt, being a compound of the white oxide of manganeſe and muriatic acid, may be called the *white muriate of manganeſe*. If any combuſtible matter be added, the ſolution of the black oxide of manganeſe in this acid goes on, without the production of oxymuriatic acid.

2. Oxymuriatic acid readily parts with its oxygen to manganeſe, which is thus converted into the white oxide. It combines alſo with the oxides of manganeſe, and forms ſolutions of a brown, red, or violet-colour, which afford cryſtals of the ſame colour. There is, therefore, a red muriate of manganeſe.

It is from the black oxide of manganeſe, that oxymuriatic acid is obtained, either by adding to the oxide muriatic acid, part of which combines with the oxygen of the manganeſe, and is converted into oxymuriatic acid; or, by adding ſulphuric acid to a mixture of the black oxide of manganeſe and muriate of ſoda. The ſulphuric acid decompoſes the latter, and the muriatic acid being diſengaged, combines with part of the oxygen of the manganeſe, and forms oxymuriatic acid.

4. Fluate of Manganeſe.

Fluoric acid has little action on manganeſe or its oxides; but a fluate of manganeſe may be formed by double affinity, by adding an alkaline fluate to the nitrate or muriate of manganeſe. The fluate of manganeſe thus formed, is not very ſoluble in water. Its other properties are unknown.

5. Borate of Manganeſe.

This ſalt may be formed in the ſame way as the former. It is equally ſoluble in water, and its other properties are alſo unknown.

6. Phoſphate of Manganeſe.

A phoſphate of manganeſe may be formed in the ſame way as the two former ſalts. It is not very ſoluble in water, and its other properties have not been examined.

7. Carbonate of Manganeſe.

Liquid carbonic acid diſſolves a ſmall portion of manganeſe, as well as of its black oxide. When this ſolution is expoſed to the air, the oxide is gradually precipitated, and appears on the ſurface in the form of a white pellicle. Bergman has remarked, that during the combination of manganeſe with carbonic acid, there is evolved an odour ſomewhat analogous to that of burnt fat.

8. Arſeniate of Manganeſe.

Arſenic acid combines with the white oxide of manganeſe, and forms an arſeniate. The arſenious acid, or white oxide of arſenic, deprives the black oxide of manganeſe of part of its oxygen, and paſſes to the ſtate of arſenic acid, and then combines with the manganeſe, now reduced to the ſtate of white oxide. When the arſenic acid is nearly ſaturated with the oxide, the ſolution becomes thick, and ſmall cryſtals make their appearance. This ſalt, when heated, does not melt, nor is the arſenic ſublimed, without the addition of charcoal.

9. Tungſtate of Manganeſe.	Unknown.
10. Molybdate of Manganeſe.	
11. Chromate of Manganeſe.	
12. Columbate of Manganeſe.	

13. Acetate of Manganeſe.

1650 Proceſs for ſeparating iron. Acetic acid diſſolves part of the black oxide of manganeſe, but acts very feebly on the metal itſelf. This acid may be employed to ſeparate manganeſe from iron; for when it is added to a ſolution containing both theſe metals, the acid combines with the manganeſe, for which it has a ſtronger affinity, and leaves the oxide of iron. Several ſucceſſive ſolutions and evaporations are neceſſary to ſeparate the whole of the iron, which is known when the ſolution becomes colourleſs, and when it affords a white precipitate with pruſſiate of potaſh. The ſolution of acetate of manganeſe does not cryſtallize, and when evaporated to dryneſs, it ſoon deliqueſces *.

14. Oxalate of Manganeſe.

Oxalic acid forms a ſalt with the oxide of manganeſe, which, when the ſolution is ſaturated, precipitates in the form of white powder. It may be formed alſo by adding oxalic acid to the ſulphate, nitrate, and muriate of manganeſe in ſolution.

15. Tartrate of Manganeſe.

This ſalt may be formed by double affinity, by adding tartrate of potaſh to the ſolution of manganeſe in ſulphuric or nitric acids. The black oxide of manganeſe is diſſolved in tartaric acid, and gives a black-coloured ſolution. When it is heated, an effervеſcence takes place; the acid is partially decompoſed, carbonic acid gas is evolved, and the ſolution at laſt becomes colourleſs.

16. Citrate of Manganeſe.

Citric acid, in its combination with the black oxide of manganeſe, exhibits the ſame phenomena as the former.

17. Benzoate of Manganeſe.

Benzoic acid readily combines with the white oxide of manganeſe. By evaporation, cryſtals in the form of ſmall ſcales are obtained, which are little altered by expoſure to the air, and are ſoluble in water.

II. Action of Alkalies on Manganeſe.

1651 Pure alkalies. 1. The pure alkalies favour the oxidation of manganeſe, and the decompoſition of water, becauſe they combine readily with this oxide. In the dry way, the fixed alkalies fuſe with manganeſe, and form a maſs of a deep green colour, which is ſoluble in water, and communicates to it the ſame colour. If this ſolution be kept in a cloſe veſſel, there is precipitated an oxide of manganeſe, of a yellowiſh colour, and the green liquid changes to a blue. Water precipitates the alkaline ſolution, and converts it, firſt to a violet and then to a red colour. As the particles of the oxide collect together, the liquid becomes white. The addition of a few drops of acid, on expoſure to the air, produces the ſame precipitation and the ſame ſhades of colour, by oxidating the manganeſe. The white oxide of arſenic, or arſenious acid, added to this alkaline ſolution, deprives it of the whole of its colour, and renders it white, by combining with the oxygen. By adding charcoal to the oxide of manganeſe which has been fuſed with an alkali, an effervеſcence takes place, with the evolution of carbonic acid, and the colour of the ſolution changes to a grayiſh white. The carbonic acid is here formed by the union of the carbone of the charcoal with the oxygen of the manganeſe, and this latter paſſes to the ſtate of white oxide. On account of theſe remarkable changes of colour, and the different ſhades which this liquid, treated in various ways, aſſumes, this compound has received the name of *mineral chameleon*. 1652 Mineral chameleon.

1653 Ammonia. 2. Scheele had obſerved the change which ammonia undergoes by the action of oxide of manganeſe, in the diſtillation of this oxide with the muriate of ammonia. He ſuſpected that the ammonia was partially decompoſed, and to this decompoſition he aſcribes the formation of a gas, which he obtained by this proceſs, and which he found to be different from carbonic acid. Berthollet has ſhewn, that in this proceſs, the hydrogen, leaving the ammonia which is decompoſed, combines with the oxygen of the oxide of manganeſe, and forms water; and the azote, the other component part of ammonia, is ſet at liberty.

1654 Curious experiment. A very intereſting experiment was contrived by Dr Milner, which illuſtrates the reciprocal action, and decompoſitions of the oxide of manganeſe and ammonia. He filled a tube with oxide of manganeſe, expoſed it to a red heat, and made a ſtream of ammoniacal gas paſs through it. The gas was decompoſed, and its azote combining with the oxygen of the oxide, formed nitrous gas.

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* *Ann. de Chim.* xli. p. 249.

Some of the alkaline ſalts have peculiar effects on the oxides of manganeſe and their compounds. The ſulphates have the property of deſtroying the colour of glaſs, which has been communicated by manganeſe; but for this effect a high temperature is neceſſary. The nitrates readily burn this metal, and oxidate it ſtrongly. Melted nitre gives a violet or red colour to glaſs, which has been rendered colourleſs, by reſtoring to it the oxygen of which it has been deprived by the fuſion of the glaſs. With the nitrate of potaſh and the black oxide of manganeſe, heated in a crucible to redneſs, a compound is formed, ſimilar to that which is the reſult of the direct combination of the oxide with the alkali.

The alkaline phoſphates and borates fuſed by means of the blow-pipe, with the oxide of manganeſe, produce various colours, according to the degree of oxidation, and the intenſity of the heat.

A white precipitate is formed, by adding hydroſulphuret of potaſh to the ſalts of manganeſe, and a yellowiſh-white precipitate is obtained, by means of the triple pruſſiate of potaſh.

III. Action of the Earths on Manganeſe.

1655 Colours glaſs. There is no action between manganeſe and any of the earths; but its oxide combines with them, and forms vitreous matters, which are of different colours, according to the degree of oxidation of the manganeſe, and its mixture with iron. In general theſe colours are green, brown, black, or yellowiſh green.

1656 Uſes. Manganeſe and its oxides are of great importance, both in chemiſtry and in the arts. This muſt be obvious, from the minute detail of its properties and combinations, which has now been given.

Sect. XI. *Of Bismuth and its Combinations.*

1657 Hiſtory. 1. Biſmuth, it would appear, was known to the ancients, to the alchemiſts, and ſome of the earlieſt mineralogiſts; but it was conſidered merely as a variety of ſome other metal, and generally of tin and lead. Hence it was diſtinguiſhed by the name of *green tin*, *gray lead*, and *white antimony*. It was not till the year 1753, when its properties were particularly examined by Pott and Geoffroy the younger, that it was aſcertained to be a peculiar metal. Darcet and Rouelle afterwards inſtituted a ſet of experiments on this metal, and diſcovered more of its properties. Monnet and Beaume inveſtigated its principal combinations at ſtill greater length; and Bergman examined with more accuracy, ſome of its compounds and precipitates.

1658 Ores. 2. Biſmuth is found native in the ſtate of ſulphuret, and in that of oxide. Native biſmuth is eaſily diſtinguiſhed by its colour, brittleneſs, and fuſibility. The ſulphuret of biſmuth is of a bluiſh gray, ſometimes with a yellowiſh ſhade, and is in irregular maſſes, or cryſtallized in the form of ſmall priſms. It has a brilliant, lamellated fracture. The native oxide of biſmuth accompanies the metal, or is found on the ſurface of the ſulphuret. It is of a greeniſh yellow colour.

1659 Analyſis in the dry way. 3. Biſmuth is eaſily extracted from its ores. The mineral, after being reduced to powder, and well waſhed, is mixed with about $\frac{1}{3}$ of its weight of black flux, is put into a crucible lined with charcoal, and well covered. It is then expoſed to a moderate heat, which muſt be quickly applied, to prevent the metal from being ſublimed. By this proceſs a metallic button is obtained.

1660 Humid way. In the humid way, the ore of biſmuth being reduced to powder, is diſſolved in nitric acid, and precipitated from this ſolution by water. If the native biſmuth be combined with any other metals, they remain in the ſolution. The ſulphuret of biſmuth is alſo diſſolved in the ſame acid by boiling. The ſulphur is ſeparated, as the metal, being oxidated, combines with the acid. The native oxide is treated in the ſame way, and is precipitated by water.

1661 Properties. 4. Biſmuth is of a white colour, inclining to yellow, exhibiting a texture compoſed of large brilliant plates. Its ſpecific gravity is 9.822. It has ſcarcely either taſte or ſmell. By a violent ſtroke of the hammer it is broken, and divides into ſmall fragments of a lamellated ſtructure; the figure of its particles is the regular octahedron. It has conſiderable hardneſs; and by hammering, its denſity may be increaſed. It has very little elaſticity, and no ductility. Biſmuth is very fuſible. When it is expoſed to the temperature of 490°, according to Guyton, it melts; and, if after fuſion, it be allowed to cool ſlowly, it cryſtallizes in parallelopipeds which croſs each other at right angles. This metal cryſtallizes more eaſily and more regularly than any other yet known. If the heat be long continued after the fuſion, and ſufficiently ſtrong; and if the proceſs be conducted in cloſe veſſels, it ſublimes, and attaches itſelf to the upper part of the apparatus, where it cryſtallizes in brilliant plates.

5. Biſmuth is but ſlightly affected by expoſure to the air in the cold. It loſes its brilliancy, and is covered with a fine powder of a yellowiſh gray colour; but, when it is heated in contact with air, the ſurface is ſoon covered with an irideſcent pellicle, which, by agitation and continuing the heat, is converted into a greeniſh gray or brown-coloured oxide. It acquires about $\frac{1}{11}$ of addition to its weight. By continuing the heat, and occaſionally ſtirring the fuſed metal, it becomes of an orange-yellow colour, and acquires a farther addition to its weight. If the metal in fuſion be expoſed to a red heat, it takes fire with a ſlight exploſion, burns with a bluiſh flame, and is ſublimed in the form of a yellowiſh vapour, which, being condenſed and collected, is known under the name of *flowers of biſmuth*. It appears then, that biſmuth combines with oxygen in two proportions. The firſt, or the ſmaller proportion, is that of the brown oxide; and the ſecond is the yellow oxide or flowers of biſmuth. 1662 Two oxides, brown and yellow.

1663 Phoſphuret. 6. There is no action between biſmuth and azote, hydrogen, or carbone. It combines but in very ſmall proportion with phoſphorus, forming a phoſphuret. When phoſphorus is dropped into biſmuth in fuſion, it ſeems to unite with it, according to Pelletier, in the proportion of four parts in the hundred. But the properties of the biſmuth are very little changed.

1664 Sulphuret. 7. Sulphur unites readily with biſmuth. When equal parts of biſmuth and ſulphur are heated together in a crucible, the fuſion of the metal is greatly retarded. It requires a higher temperature than when the metal is alone. This ſulphuret of biſmuth is of a ſhining dark gray colour, and cryſtallizes by proper cooling into needle-form priſms, ſhaded with ſplendid blue and deep red colours. The cryſtals are obtained by piercing the ſurface when it becomes ſolid after fuſion, and pouring out the liquid parts: a cavity is thus left in which they are formed.

Sulphurated hydrogen gas occaſions a dark colour on the ſurface of biſmuth, and converts the oxides into a deep black colour, which is the commencement of reduction.

1665 Alloys and ſalts. 8. Biſmuth combines with many of the metals, and forms alloys; but its combinations with the metals already deſcribed, are little or ſcarcely at all known. Biſmuth alſo combines with the acids, and forms ſalts.

1666 Affinities. 9. The affinities of biſmuth and its oxides are arranged by Bergman in the following order:

BISMUTH.	OXIDE OF BISMUTH.
Lead,	Oxalic acid,
Silver,	Arſenic,
Gold,	Tartaric,
Mercury,	Phoſphoric,
Antimony,	Sulphuric,
Tin,	Muriatic,
Copper,	Nitric,
Platina,	Fluoric,
Nickel,	Saclactic,
Iron,	Succinic,
Sulphur.	Citric,
	Lactic,
	Acetic,
	Pruſſic,
	Carbonic.

I. Salts of Biſmuth.

1667 Different from other metallic ſolutions. The ſolutions of biſmuth in the acids, and alſo the cryſtallized ſalts which are obtained from them, reſemble each other, but differ from almoſt all other metallic ſolutions, as well as from all other ſalts; and particularly in one circumſtance, which is, that water in ſufficient quantity decompoſes them, and precipitates an oxide of biſmuth of a white colour. This ſhows that biſmuth is ſtrongly oxidated by the action of the acids, to which it adheres with no great affinity, and that it forms with them compounds which are not very permanent. It ſeems at the ſame time remarkable, that this metal ſhould be more oxidated in this way, than by the uſual proceſs of oxidation, by means of heat, and by the action of water; and that it ſhould have a white colour, while in the uſual way, it is of a yellowiſh gray.

1. Sulphate of Biſmuth.

Concentrated ſulphuric acid has no action on biſmuth in the cold; but this metal decompoſes the acid at a boiling temperature. Sulphurous acid gas is diſengaged, and the biſmuth is oxidated, and converted into a white powder. If the heat be ſtrong, ſulphur is ſublimed. When the remaining maſs is waſhed with water, it carries off the remaining acid and a ſmall quantity of the oxide of biſmuth. The ſolution, by proper evaporation, affords ſmall ſoft needle-formed cryſtals, which are ſulphate of biſmuth. This ſulphate is decompoſed by water, which ſeparates a white oxide.

2. Sulphite of Biſmuth.

Sulphurous acid has no action on biſmuth; but it unites with its oxide, and forms a white ſulphite which is inſoluble in water, and even in its own acid; of a ſulphurous taſte; fuſible by the blow-pipe into a reddiſh yellow maſs, which is reduced on charcoal into metallic globules; decompoſed with effervescence by means of ſulphuric acid; giving out by diſtillation ſulphurous acid, and leaving behind a pure white oxide.

3. Nitrate of Biſmuth.

1668 Violent action. 1. Nitric acid exhibits a very violent action with biſmuth. When the acid is a little concentrated, and the biſmuth in the ſtate of powder, there is a violent effervescence, with the evolution of nitrous gas. There is at the ſame time great heat produced. The biſmuth is converted into white oxide at the expence of the acid, and when the action ceaſes, if no more acid be added than what is neceſſary to its oxidation, remains dry.

1669 Properties. 2. The nitric ſolution, thus prepared, is colourleſs, and affords cryſtals by evaporation. It cryſtallizes in tetrahedral priſms, compreſſed into obtuſe three-ſided ſummits. It has ſometimes been obtained in flattened rhomboidal parallelopipeds, ſimilar to thoſe of Iceland cryſtal. When this ſalt is thrown on red-hot coals, it melts, boils, and frothes up; exhales nitrous vapour, and leaves behind a greeniſh yellow oxide. It dries in the air, and becomes moiſt when the air is humid. When it is brought into contact with water, it becomes turbid, is decompoſed, and a white oxide is precipitated. This decompoſition is effected with the nitric acid, which is poured gradually into a large quantity of water. The oxide which is thus obtained, was formerly called *magiſtery of biſmuth*. It is known in the ſhops by the name of *pearl white*. It becomes of a deep gray, brown, or even black colour, when it is expoſed to the action of ſulphurated hydrogen gas.

4. Muriate of Biſmuth.

1670 Preparation. Muriatic acid has but a feeble action on biſmuth. It is neceſſary to aſſiſt its action, that the acid be concentrated, and long digeſted with the metal, or diſtilled off it in the ſtate of powder. During the proceſs, a fetid odour is emitted, which is owing to the decompoſition of water, its oxygen combining with the metals, and the hydrogen being ſet at liberty. By evaporating this ſolution, ſmall needles of muriate of biſmuth are obtained; but only in very ſmall quantity; for the greateſt part of the oxide of biſmuth is ſeparated by water. The muriate is ſublimed by heat into a thick, ſolid, fuſible matter, which was formerly called *butter of biſmuth*. It is deliqueſcent, and may be decompoſed by water, which ſeparates a very fine white oxide.

Oxymuriatic acid readily diſſolves biſmuth, and forms with the oxide which is previouſly produced, a ſalt ſimilar to the preceding.

5. Fluate of Biſmuth.
6. Borate of Biſmuth.

Theſe two ſalts may be formed by adding a fluate or borate of an alkali to a ſolution of nitrate of biſmuth. A white precipitate is formed of the fluate or borate of biſmuth; but little is known of their properties.

7. Phoſphate of Biſmuth.

This ſalt is formed by combining the acid with the oxide of the metal, when precipitated by an alkali. The phoſphate of biſmuth is in the ſtate of an inſoluble white powder.

8. Carbonate of Biſmuth.

This ſalt may be formed by precipitating the oxide of biſmuth from its ſolution in acids, by means of an alkaline carbonate.

9. Arſeniate of Biſmuth.

Arſenic acid acts upon biſmuth with the aſſiſtance of heat. A white powder appears on the ſurface of the metal, and the oxide is precipitated from the ſolution, by adding water. The arſeniate of biſmuth may be formed by adding arſenic acid to a ſolution of the nitrate of biſmuth. The arſeniate of biſmuth falls to the bottom in the form of precipitate.

10. Tungſtate of Biſmuth.

Unknown.

11. Molybdate of Biſmuth.

Muriate of biſmuth is precipitated, if there be no exceſs of acid, by molybdic acid. The molybdate of biſmuth thus formed, is of a white colour.

12. Chromate of Biſmuth. } Unknown.
13. Columbate of Biſmuth. }

14. Acetate of Biſmuth.

This ſalt may be formed, by adding a ſolution of acetate of potaſh to a ſolution of nitrate of biſmuth. A precipitate of acetate of biſmuth is formed. The addition of acetic acid to the nitrate of biſmuth, Guyton obſerves, prevented the latter from being precipitated by means of water.

15. Oxalate of Biſmuth.

Oxalic acid combines with the oxide of biſmuth, and forms with it a ſalt in the ſtate of white powder, which is ſcarcely ſoluble in water. Oxalic acid added to nitrate of biſmuth, occaſions a precipitate in the form of ſmall tranſparent cryſtals, which are oxalate of biſmuth.

16. Tartrate of Biſmuth.

Tartaric acid added to the ſolution of biſmuth in any of the mineral acids, precipitates the oxide in the form of a white powder, which is the tartrate of biſmuth, and is inſoluble in water.

17. Benzoate of Biſmuth.

Benzoic acid combines readily with the oxide of biſmuth. The ſolution, by evaporation, affords cryſtals in the form of needles. They undergo no change by expoſure to the air, are ſoluble in water, and decompoſed by ſulphuric and muriatic acids. This ſalt is alſo decompoſed by heat, which drives off its acid.

18. Succinate of Biſmuth.

Succinic acid combines with the oxide of biſmuth, at a boiling heat. By evaporating the ſolution, cryſtals of ſuccinate of biſmuth are obtained, in the form of plates, and of a yellow colour.

II. Action of Alkalies, Earths, and Salts, on Biſmuth.

1671 Alkalies. 1. Scarcely any thing is known of the action of the alkalies on biſmuth. Ammonia, it is ſaid, communicates to it a yellow colour, and the oxide of biſmuth is ſoluble in ammonia in the liquid ſtate.

1672 Silica. 2. The oxide of biſmuth combines by fuſion, with ſilica, to which it communicates a greeniſh yellow colour.

1673 Salts. 3. Biſmuth is not changed by the action of the ſulphates or ſulphites. It is oxidated by the nitrates. When it is ſtrongly heated, and thrown into a red-hot crucible with nitrate of potaſh, it detonates feebly, and without much inflammation. It is reduced to the ſtate of oxide, of which one part combines with the potaſh. Biſmuth has no action on muriate of ammonia, but its oxide very readily decompoſes this ſalt. In the cold, it diſengages a little ammonia, by ſimple trituration; but when expoſed to heat, it is totally decompoſed, and there remains a muriate of biſmuth.

1674 Uſes. 4. Biſmuth is applied to a great many uſes. It forms ſome important alloys with the ſofter metals, to give them hardneſs and conſiſtency. The oxides of biſmuth are of ſtill more extenſive utility. It is employed in this form by the manufacturers of porcelain, for the preparation of yellow enamels, and it is mixed with other oxides, to give variety of ſhade to their colours. It is ſometimes employed in the fabrication of coloured glaſſes, to communicate a greeniſh yellow. The white oxide, which is moſt commonly employed for theſe different purpoſes, is alſo employed as a paint for the ſkin, under the name of *pearl white;* but it is extremely improper for this purpoſe, for, beſides the injury which it does to the ſkin, it becomes black, when it is expoſed to the action of ſulphurated hydrogan gas. It is ſometimes uſed alſo, to give a black colour to the hair.

SECT. XII. *Of Antimony and its Combinations.*

1675 Hiſtory. 1. It does not appear that the ancients were acquainted with antimony as a diſtinct metal, although it is ſuppoſed that it was employed by them in alloys of other metals. It is ſaid, that they were acquainted with the oxide of antimony, and that it was employed as an external remedy in inflammation of the eyes. As a peculiar metal it was not certainly known till the time of Baſil Valentine, who lived about the end of the 15th century. In his work, entitled *Currus Triumphalis Antimonii*, he has detailed all that was then known of this metallic ſubſtance, and he has particularly deſcribed the proceſs by which it is extracted from its ore.

No ſubſtance has been more the ſubject of inveſtigation than antimony, and on no ſubject, perhaps, has there been ſo much written. The alchemiſts regarded antimony as peculiarly appropriate to the object of their reſearches. Their labours on this ſubject were almoſt incredible; and indeed this is ſcarcely to be wondered at, ſince it appears that they were inſpired with the hope of making, by its means, the fortunate diſcovery of the univerſal medicine. It was therefore tortured and tried in every poſſible way, to obtain the object of their reſearches; and on this account it is almoſt impoſſible to reckon up the number of medicinal preparations which were propoſed and employed with this metal and its ores. It is owing to theſe views and reſearches, concerning antimony, that its nature and properties are now ſo fully known.

2. About the end of the 17th century, Lemery publiſhed a treatiſe, which was the firſt correct and rational account of antimony. In this he arranged and detailed the diſcoveries of his predeceſſors, and added ſome of his own, with a number of curious experiments and accurate proceſſes for many of the preparations of antimony and its ſulphuret. Mender afterwards publiſhed a very complete hiſtory of all the facts that were then known concerning antimony; and it has been ſince examined by more modern chemiſts; among whom Bergman, Scheele, Berthollet, Prouſt, and Thenard, are the principal writers on this ſubject.

1676 Ores.

3. Antimony exiſts in nature in four different ſtates: In the ſtate of native antimony, that of ſulphuret, hydroſulphuret of the oxide of antimony, and muriate. Native antimony is eaſily diſtinguiſhed by its colour and brilliancy. It has been found in Sweden and in France. The moſt common ore of antimony is the ſulphuret, which is of a grayiſh colour, and ſtains the fingers. It is ſometimes cryſtallized in ſquare priſms, which are ſlightly rhomboidal, and terminated by four-ſided pyramids. The hydroſulphurated oxide of antimony is in ſhining filaments, of a deep red colour, diſpoſed in rays going from a common centre, adhering to the ſurface or cavities of the ſulphuret. The muriate of antimony, which is a rare production, is of a brilliant, pearly-white colour, in the form of ſmall divergent needles, ſomewhat reſembling radiated zeolite.

1677 Analyſis.

4. To obtain the pure metal from the ſulphuret of antimony, the ore is firſt roaſted, to ſeparate the greateſt part of the ſulphur. It is then mixed with its own weight of black flux, formed into a paſte with oil, and expoſed to a ſtrong heat in a crucible, at the bottom of which the metal is found reduced. By a ſhorter proceſs, eight parts of ſulphuret of antimony, ſix of tartar, and three of nitre, reduced to powder, and well mixed, are projected in ſmall quantities into a red-hot crucible. At each projection there is a ſtrong detonation; the tartar forms, by means of the nitre, a black flux, and the ſulphuret being burnt, the metal is fuſed, but not oxidated, on account of the charcoal of the tartar with which it is ſurrounded, and the liquid alkali which covers it. The whole is then fuſed in a conical iron pot; and, when it is cool, the metallic antimony is found at the bottom, marked on its ſurface with needle-ſhaped cryſtals, arranged in the form of a ſtar.

1678 Properties.

5. Antimony, in a ſtate of purity, is of a brilliant white colour, having a good deal of reſemblance to that of ſilver or of tin. It has a lamellated texture, compoſed of plates which croſs each other in all directions. It exhibits ſometimes perceptible traces of cryſtallization. The form of the cryſtals, which was diſcovered with difficulty by Hauy, on account of its complicated ſtructure, is the octahedron, compoſed of a great number of regular tetrahedrons. Antimony has a very perceptible taſte and ſmell, and particularly if it is rubbed for ſome time on the hands. The ſpecific gravity is 6.702. It is very brittle, ſo that it can be reduced to powder, which is of a grayiſh white colour.

1679 Action of water.

6. Antimony undergoes no change by being expoſed to the air, nor is there any perceptible action between antimony and water in the cold; but when water comes in contact with antimony red hot, it is inſtantaneouſly decompoſed, and accompanied with a violent detonation, and a very brilliant white flame. Accidents of this kind have happened, attended with conſiderable danger.

1680 Of heat.

7. When antimony is heated to the temperature of 808°, it melts. If the heat be continued after its fuſion, it is ſublimed, and if the proceſs be performed in cloſe veſſels, it is condenſed in ſhining cryſtallized plates. If it be allowed to cool ſlowly, and part of it be poured off when the ſurface becomes ſolid, the cavity is lined with pyramidal cryſtals, compoſed of ſmall octahedrons.

1681 Oxides.

8. When antimony is kept in fuſion in the open air, it riſes in the form of white vapour, which is precipitated on the ſurface of the metal or upper part of the crucible, and cryſtallizes in long priſms, or in ſmall, white, brilliant needles. This is an oxide of antimony, which was formerly called *argentine flowers*, or *ſnow of regulus of antimony*. By this proceſs it is found, that the antimony has acquired an addition of weight of about 50 per cent. This oxide may be obtained, by expoſing the antimony in a crucible to a white heat, and then by ſuddenly agitating it in contact with air, it takes fire with a kind of exploſion, and burns with a white light.

Thenard, in his reſearches concerning antimony, diſtinguiſhes ſix different degrees of oxidation of this metal. But in a memoir on the ſame metal by Prouſt, he conſiders that the oxides of antimony may be reduced to two. According to the experiments of this chemiſt, 100 parts of antimony treated with nitric acid in a retort, uniformly afford 130 of a yellow oxide in the ſtate of powder. It is reduced to 126 by waſhing with water before drying it, becauſe the nitric acid diſſolves a ſmall proportion. This oxide is not reduced by being expoſed to a red heat, but it is ſublimed, and condenſed in cloſe veſſels, in groups of cryſtals. It is inſoluble in water. It is the ſame oxide which was formerly diſtinguiſhed by the name of *argentine flowers*. The component parts of this oxide, according to Prouſt, are,

Antimony,	77
Oxygen,	23
	100*

The oxide with a ſmaller proportion of oxygen, is formed by diſſolving antimony in muriatic acid; and by adding water to the ſolution, a white powder is precipitated, which being waſhed, is ſeparated from any acid that may adhere to it. To purify it ſtill more, it is to be boiled with carbonate of potaſh, and afterwards waſhed, and dried on a filter. This oxide is of a yellowiſh white colour, and has little brilliancy; it melts at a moderate red heat, and when it is allowed to cool, it cryſtallizes on the ſurface. The cryſtals are of a yellowiſh white colour, which are thrown together in heaps, in a radiated form. This oxide was formerly known by the name of *powder of algaroth*. Its component parts are,

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* Jour. de Phyſ. lv. p. 320.

Antimony	81.5
Oxygen	18.5
	100.0*

9. There is no action between antimony and azote, hydrogen, or carbone.

1682 Phoſphuret. 10. Antimony enters into combination with phoſphorus, and forms with it a phoſphuret. Equal parts of phoſphoric glaſs and antimony are fuſed together in a crucible, or with the addition of $\frac{1}{8}$ of charcoal, or by projecting pieces of phoſphorus on the metal in fuſion in a crucible; and thus a phoſphuret of antimony is obtained. The phoſphuret has a metallic luſtre, is brittle, and has a lamellated fracture. When it is placed on burning charcoal, it melts, gives out a ſmall green flame, and is converted into the white oxide of antimony, which is ſublimed.

1683 Sulphuret. 11. Antimony combines very readily with ſulphur, and forms with it an artificial ſulphuret, which is exactly ſimilar to the native ſulphuret. It is formed by mixing the antimony and the ſulphur together, and fuſing them in a crucible. This ſulphuret is of a brilliant gray colour, is more fuſible than the metal itſelf, and by ſlow cooling, may be obtained in cryſtals. The component parts of the ſulphuret, according to Prouſt, are,

Antimony,	75.1
Oxygen,	24.9
	100.0

1684 Oxides with ſulphur. 12. The yellow oxide of antimony combines with different proportions of ſulphur, and forms compounds of different colours, and which were formerly diſtinguiſhed by different names. With eight parts of the oxide and one part of the ſulphuret, a red-coloured, ſemitranſparent maſs is obtained, which was formerly called *glaſs of antimony*. When two parts of ſulphuret are added to eight parts of the oxide, a yellowiſh maſs is formed, which was known by the name of *crocus metallorum*. Six parts of oxide and one of ſulphur, form a dark red, opaque maſs, with a vitreous fracture, which is the true *liver of ſulphur*. In theſe combinations, the ſulphur deprives the oxide of part of the antimony, and combines with it, forming a ſulphuret. This ſulphuret then combines with the oxide†.

1685 Affinities. 13. Antimony enters into combination with the acids, and forms ſalts. It alſo forms alloys with many of the metals. The affinities of antimony and of its oxides are, according to Bergman, in the following order:

Antimony.	Oxide of Antimony.
Iron,	Muriatic acid,
Copper,	Oxalic,
Tin,	Sulphuric,
Lead,	Nitric,
Nickel,	Tartaric,
Silver,	Saclactic,
Biſmuth,	Phoſphoric,
Zinc,	Citric,
Gold,	Succinic,
Platina,	Fluoric,
Mercury,	Arſenic,
Arſenic,	Lactic,
Cobalt,	Acetic,
Sulphur.	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Antimony.

1. Sulphate of Antimony.

Sulphuric acid has no action on antimony in the cold. At a boiling temperature the acid is decompoſed; ſulphurous acid gas is emitted with efferveſcence, and if diſtilled in a retort to dryneſs, ſulphur is ſublimed. There remains a white oxide of antimony. If this maſs be waſhed with water, the acid which adheres to it is carried off, with a ſmall portion of the oxide; and what remains is the white oxide, which is inſoluble. By adding a large quantity of water to the ſolution, the oxide which it had carried off is precipitated; but this ſolution being evaporated yields no cryſtals. It is decompoſed by the earths and the alkalies, which precipitate a white oxide. Sulphuric acid, therefore, oxidates antimony, but does not ſeem to have the property of forming a ſalt.

2. Sulphite of Antimony.

Sulphurous acid, with the aſſiſtance of heat, is decompoſed by antimony. The metal is oxidated, and there is formed a ſulphite of antimony. This ſalt may be alſo obtained by adding ſulphurous acid to the ſolution of antimony in muriatic acid. A white precipitate appears, which is inſoluble, of an acrid, bitter taſte, and is decompoſed by heat. When it is diſtilled in cloſe veſſels, it yields a little ſulphurous acid, then ſulphuric acid, and the reſiduum is a reddiſh brown maſs, which is ſoluble in fixed alkali, and may be precipitated by means of muriatic acid, into a hydroſulphuret of antimony.

3. Nitrate of Antimony.

Nitric acid is rapidly decompoſed by antimony, even in the cold. There is evolved a great quantity of nitrous gas, and ſometimes the rapidity of the oxidation is ſuch, that it is accompanied with actual combuſtion. The water alſo is partially decompoſed. The antimony is converted into a white oxide. The hydrogen of the water combines with the azote of the acid, and forms ammonia, which combines with part of the nitric acid, and the compound is nitrate of ammonia. The ſmall quantity of oxide of antimony which is diſſolved in nitric acid, is precipitated by water, ſo that it adheres very ſlightly to the acid.

4. Muriate of Antimony.

Muriatic acid acts on antimony very feebly. By digeſting the metal with the acid for a long time, it diſſolves a ſmall quantity, and the ſolution becomes of a yellowiſh colour. The white oxide is more ſoluble in this acid, and forms with it a colourleſs ſolution. The firſt ſolution yields cryſtals by evaporation, in the form of ſmall needles, which are deliqueſcent, and ſublimed by heat, and are precipitated and decompoſed by water. The ſolution formed with the oxide is fixed in the fire, and cryſtallizes in brilliant plates. It is alſo decompoſed by water. Muriatic acid diſſolves more readily the ſulphuret of antimony, for it does not require the aid of heat. There is diſengaged a ſtrong odour of ſulphurated hydrogen gas. When the mixture is heated, the whole of the metal is diſſolved.

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* Jour. de Phyſique, lv. p. 330.

† Ibid. lv. p. 330.

Nitromuriatic acid diſſolves antimony more readily than any of the acids which have been mentioned. This ſolution is colourleſs. The muriate of antimony which remains after the evaporation, by being diſtilled, comes over of a thicker conſiſtence, in proportion as it is concentrated. This muriate of antimony was formerly called *butter of antimony*. It is of a grayiſh white colour, and ſometimes cryſtallizes in four-ſided priſms. It is deliqueſcent in the air, and extremely cauſtic and corroſive. When it is diluted with water, a white powder is precipitated, which is the *powder of algaroth*.

5. Fluate of Antimony.

6. Borate of Antimony.

Fluoric and boracic acids have no action on antimony, but combine with its oxide, or precipitate it from its ſolution in acids, in the form of white powder, forming a fluate or borate of antimony.

7. Phoſphate of Antimony.

Phoſphoric acid combines with the oxide of antimony. The ſolution, by evaporation, yields a blackiſh green maſs.

8. Phoſphate of Lime and Antimony.

1686 James's powder.

This triple ſalt is formed by calcining together equal parts of ſulphuret of antimony and the aſhes of bones; or, according to the proceſs recommended by Mr Chenevix, by diſſolving white oxide of antimony and phoſphite of lime in equal parts in muriatic acid; and then by adding this ſolution to a ſufficient quantity of diſtilled water, which contains pure ammonia. A precipitate is formed in the ſtate of white powder. This powder is nearly inſoluble in water. It has been long known as a diaphoretic and emetic, under the name of *James's powder*. According to the analyſis of Dr Pearſon, it is compoſed of

Phoſphate of lime,	43
Oxide of antimony,	57
	100

9. Carbonate of Antimony.

Unknown.

10. Arſeniate of Antimony.

By digeſting together arſenic acid and antimony, a white powder is obtained, which is arſeniate of antimony. Muriatic acid diſſolves this powder, but it may be ſeparated by adding water. This ſalt may be formed alſo, by adding an alkaline arſeniate to the ſolution of antimony in muriatic, tartaric, or acetic acids.

11. Molybdate of Antimony.

Muriate of antimony is precipitated by molybdic acid; and if the acid be not in exceſs, the precipitate is white.

12. Acetate of Antimony.

Acetic acid diſſolves a ſmall portion of the oxide of antimony, and according to ſome, yields ſmall cryſtals. The acetate of antimony has been employed as an emetic.

13. Oxalate of Antimony.

Oxalic acid combines with the oxide of antimony, and the ſolution affords cryſtals in the form of ſmall grains, which are ſcarcely ſoluble in water.

14. Tartrate of Antimony.

Tartaric acid alſo combines with a ſmall portion of the oxide of antimony, and affords a ſalt which aſſumes the form of jelly.

15. Tartrate of Potaſh and Antimony.

1687 Tartar emetic.

This triple ſalt was formerly prepared by boiling together the preparation of what was called crocus metallorum, and tartar, in water. But if the white oxide be mixed with its own weight of tartar, and the mixture boiled in 10 or 12 parts of water, till the tartar be ſaturated, and the ſolution filtered and evaporated, cryſtals are obtained, which are cryſtals of the tartrate of potaſh and antimony, which have been long and better known by the name of *tartar emetic*. This ſalt is of a white colour, and it cryſtallizes in regular tetrahedrons. It effloreſces by expoſure to the air, and is ſoluble in 80 parts of cold, and in half that quantity of water at the boiling temperature. When it is expoſed to heat, it is decompoſed. It is alſo decompoſed by the alkalies and their carbonates.

According to the analyſis of Thenard, this ſalt is compoſed of

Antimony,	38
Acid,	34
Potaſh,	16
Water	8
	96, loſs 4.*

This ſalt has been greatly employed as a diaphoretic and emetic, from which property it has derived its name. An account of the mode of preparing a ſimilar powder, which, it is ſaid, was invented by an earl of Warwick, and became famous in Italy as a powerful and effectual medicine, was publiſhed in Italy, in the year 1620. The preparation of tartar emetic itſelf was firſt publiſhed in 1631.

16. Benzoate of Antimony.

Benzoic acid combines with the oxide of antimony, and, by evaporating the ſolution, cryſtals are obtained. This ſalt is not altered by expoſure to the air, but it is readily decompoſed by heat.

II. Action of Alkalies, &c. on Antimony.

1688 Alkalies.

1. All the alkalies have a peculiar action on the ſulphuret of antimony: Sulphuret of antimony and

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* *Ann. de Chim.* xxxviii. p. 39.

potaſh form a preparation which is known by the name of *kermes mineral*, a name which it derives from the red animal called *kermes*. This is prepared in the dry way by mixing together one part of ſulphuret of antimony and two of potaſh, and in proportion to the quantity of ſulphuret, add a ſixteenth part of ſulphur. Fuſe the mixture in a crucible, and pour it into an iron mortar. When it is cool reduce it to powder, and boil it in water; filter the liquid, and as it cools, a reddiſh brown powder is depoſited. Waſh the precipitate, firſt with cold, and then with boiling water, till it comes off inſipid. It may be prepared in the humid way, by boiling 10 or 12 parts of pure liquid alkali with two of ſulphuret of antimony, for half an hour, and then filtering the liquid; the kermes is depoſited as it cools.

The compound which is firſt formed, is a hydroſulphuret of potaſh and antimony. When boiling water is added in ſufficient quantity, the whole is diſſolved, but the ſolution becomes turbid by cooling, and divides into two parts; the one, which is depoſited in the form of a reddiſh brown powder, is the kermes mineral, and the other, which remains in ſolution, containing a ſmaller proportion of ſulphur and oxide of antimony than the former, has been diſtinguiſhed by the name of *golden ſulphur*. The cauſe of the ſeparation is, that the alkali, if it is not in great quantity, cannot hold the ſulphurated oxide of antimony in ſolution while it is cold. What remains in ſolution after the ſpontaneous precipitation, contains a greater proportion of ſulphur, and leſs of the oxide of antimony. When an acid is added to this ſolution, another precipitate is formed, which is of an orange yellow colour, from the greater proportion of ſulphur, and on this account has been called *golden ſulphur*. Kermes mineral, or the hydroſulphuret of antimony, according to Thenard, contains the following proportions.

Brown oxide of antimony,	72.760
Sulphurated hydrogen,	20.298
Sulphur,	4.156
Water and loſs,	2.786
	100.000

From the analyſis of the ſame chemiſt, the golden ſulphur, or *ſulphur auratum*, is alſo a hydroſulphuret, having a greater proportion of ſulphur, and a ſmaller proportion of the oxide. The component parts are the following.

Brown oxide of antimony,	68.300
Sulphurated hydrogen,	17.877
Sulphur,	12.000
	98.177 *

1689 Earths. 2. The oxide of antimony has the property of combining with ſome of the earths during their vitrification, and communicating to them different ſhades of colour, more or leſs yellow and orange.

1690 Salts. 3. Moſt of the ſalts have a peculiar action on antimony or its ſulphuret. By fuſing in a crucible two parts of ſulphate of potaſh and one of antimony, the metal diſappears, and a vitreous maſs of a yellow colour is formed, which has a cauſtic property. Diſſolved in hot water, it affords, on cooling, a hydroſulphuret of antimony. The antimony has carried off the oxygen of the acid, and combined in the ſtate of oxide, with the ſulphuret of potaſh, which is formed by the ſulphur of the acid uniting with the potaſh during the proceſs.

The nitrates have a powerful action on antimony and its ſulphuret. A mixture of two or three parts of nitrate of potaſh and one of antimony in fine powder, well rubbed together in a mortar, produces a lively detonation, by throwing it on burning coals, or projecting it into a red-hot crucible, or heating it to redneſs in a cloſe veſſel. This detonation is accompanied with a bright white flame; and the antimony is ſtrongly oxidated by the oxygen of the nitre, which is decompoſed, and reduced to its alkaline baſe. The reſiduum of this detonation is a white ſcorified maſs, which being waſhed with water, leaves a portion of the oxide of antimony united to a ſmall quantity of potaſh, and affords beſides, another compound, with more of the alkali. The white matter which is firſt depoſited, has been called *waſhed diaphoretic antimony*. The water which remains holds in ſolution a portion of metallic oxide, united to the potaſh of the nitre. The oxide in this caſe performs the part of an acid. This compound has been found ſuſceptible of cryſtallization. It is decompoſed by acids, and the precipitate from it, which is an oxide of antimony, has been diſtinguiſhed by the names of *ceruſe of antimony*, *magiſtery of diaphoretic antimony*, and *pearly matter of Kerkringius*.

When equal parts of nitre and ſulphuret of antimony are treated in the ſame way, a vitrified maſs is obtained, ſimilar to what has been already deſcribed, by the name of *liver of antimony*.

III. Alloys.

Antimony enters into combination with the metals, and forms alloys with them, ſome of which are of conſiderable importance. But the alloys of antimony, with the metals already deſcribed, are either little known, or have been applied to no uſe. The alloys of cobalt and nickel, with antimony, have not been examined. With mangameſe antimony forms but an imperfect alloy, and the compound of antimony and biſmuth is very brittle.

1691 Uſes of antimony. Beſides the various preparations of antimony uſed in medicine, which are now comparatively but few in number, it is much employed in many arts. In the metallic ſtate it is of the greateſt importance as an alloy with other metals which will be afterwards mentioned. In the ſtate of oxide, it is much uſed in the fabrication of coloured glaſs, and of enamels for pottery and porcelain; particularly in forming different ſhades of brown, orange, and yellow colours. The oxide is mixed with different other metallic oxides, to produce various ſhades of colour.

SECT. XIII. *Of Tellurium and its Combinations.*

1692 Hiſtory. 1. In the year 1782, Muller of Richenſtein, in examining a gold ore, diſtinguiſhed by the names of *aurum paradoxum* and *aurum problematicum*, conjectured that it contained a peculiar metal. Bergman, to whom this mineralogiſt had ſent a ſpecimen of the mineral, could not, from the ſmall quantity which he had received, aſcertain whether it was really a new metal, or merely antimony, with which it poſſeſſes ſome common properties. He inclined, however, to the former opinion. This mineral was analyzed by Klaproth in the end of the year 1797, the account of which was publiſhed in 1798. By this analyſis the conjecture of Muller was verified, and to the new metal Klaproth gave the name of *tellurium*.

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* *Ann. de Chim.* xxxii. p. 277.

2. This metal has been found in four different minerals. Firſt, in that in which Klaproth firſt detected it, which is called *white gold ore*, a mineral found in the mountains of Fatzbay in Tranſylvania. In this mineral the tellurium is combined with iron and gold. The ſecond is what is called *graphic gold ore*, which is compoſed of tellurium, gold, and ſilver. The third is known by the name of *yellow gold ore of Nagyag*. This mineral contains, beſides tellurium, gold, ſilver, and a little ſulphur. The fourth is a variety of the laſt, and is denominated *gray gold ore*. Beſides the metals in the former, it contains a little copper. To obtain the metal from the ore, a quantity of it is ſlightly heated with ſix parts of muriatic acid, and having added three parts of nitric acid, it is then boiled. A conſiderable effervеſcence takes place, and the whole is diſſolved. The ſolution being diluted with diſtilled water, is mixed with a ſolution of cauſtic potaſh, to diſſolve the precipitate; and there remains only a brown, flaky matter, formed of the oxides of gold and iron. The alkaline ſolution of the oxide of tellurium is mixed with muriatic acid, to ſaturate the potaſh, and there is depoſited a copious, very heavy, white powder. By forming this powder into a paſte with oil, and heating it to redneſs in a ſmall glaſs retort, the metal is obtained, partly fuſed and cryſtallized at the bottom of the retort, and party ſublimed at the upper part.

1693 Properties. 4. Tellurium is of a white colour, ſomewhat reſembling lead, and has a conſiderable luſtre. It is very brittle, and may be eaſily reduced to powder. It has a lamellated texture, ſimilar to antimony. By ſlow cooling it aſſumes a cryſtalline form, eſpecially on the ſurface. Its ſpecific gravity is 6.115. It is one of the moſt fuſible of the metals, and when heated in cloſe veſſels, it boils readily, and is ſublimed in the form of brilliant globules, which adhere to the upper part of the veſſels.

1694 Action of heat. 5. When tellurium is heated by the action of the blow-pipe on charcoal, it burns, after being melted, with a lively flame, of a blue colour, and green at the edges. It is entirely volatilized in the form of a grayiſh white ſmoke, diffuſing a fetid odour, which Klaproth compares to that of radiſhes.

The oxide of tellurium is very fuſible. By heating it in a retort, a yellow, ſtraw-coloured maſs is obtained, which aſſumes a radiated texture on cooling. When the oxide is heated on charcoal, and ſurrounded with it, it is ſo rapidly reduced, that it is accompanied with a kind of exploſion.

1695 Sulphuret. 6. Tellurium enters into combination with ſulphur, and forms with it a ſulphuret. This ſulphuret is of a grayiſh colour, of a radiated ſtructure, and is eaſily cryſtallized.

I. Salts of Tellurium.

1. Sulphate of Tellurium.

One part of tellurium mixed in the cold, in a cloſe veſſel, with 100 parts of concentrated ſulphuric acid, communicates to it a beautiful crimſon colour. By adding water drop by drop to this ſolution, the colour vaniſhes, and the metal is depoſited in the form of black flakes. When the ſolution is heated, the colour alſo diſappears, and the oxide of tellurium is gradually precipitated in the ſtate of white powder; but, when diluted ſulphuric acid is employed, with the addition of a ſmall quantity of nitric acid, a large portion of tellurium is diſſolved. The ſolution is tranſparent and colourleſs, and is not decompoſed by adding water.

2. Nitrate of Tellurium.

Nitric acid readily diſſolves tellurium, and forms a tranſparent, colourleſs ſolution, which being concentrated, ſpontaneouſly affords ſmall, light, white, needle-ſhaped cryſtals, diſpoſed in a dendritical form.

3. Muriate of Tellurium.

Nitromuriatic acid very readily diſſolves tellurium, which is precipitated by adding a conſiderable quantity of water in the form of oxide. This is a white powder, which is ſoluble in muriatic acid.

The infuſion of nut-galls added to ſolutions of tellurium in acid, occaſions a flaky precipitate, which is of a yellow colour.

II. Action of Alkalies and Earths.

1696 Alkalies. 1. All the pure alkalies precipitate the ſolutions of tellurium in acids, in the form of white oxide. With an exceſs of alkali the precipitate is re-diſſolved. With the alkaline carbonate a precipitate is obtained, which is much leſs ſoluble in exceſs of alkali.

2. The alkaline ſulphurets added to ſolutions of tellurium in acids, produce a brown or black precipitate, as the metal is more or leſs oxidated. This precipitate ſometimes reſembles the hydroſulphurets of antimony. The hydroſulphuret of tellurium thus formed, expoſed to heat on burning coals, burns with a ſmall blue flame, and is volatilized in white ſmoke. No precipitate is formed by the pruſſiate of potaſh.

1697 Earths. 3. The action of the oxide of tellurium with the earths is not known; but from its great fuſibility, it has been ſuppoſed that it is ſuſceptible of forming a vitreous matter with the earths, and communicating to them a ſtraw colour.

III. Action of Metals.

The alloys of tellurium are unknown.

1698 Precipitated by zinc and iron. Tellurium is ſeparated from its ſolutions in acids, by zinc and iron, in the form of ſmall, black flakes, which may be reduced to the metallic ſtate on burning charcoal, or even by ſimple friction. Antimony cauſes a ſimilar precipitation in a ſolution of nitrate and ſulphate of tellurium. Tin produces a ſimilar effect.

1699 Uses. Tellurium has hitherto been found in ſuch ſmall quantity, that it has not yet been applied to any uſe. Were it found in abundance, it has been ſuppoſed, from its eaſy fuſibility, that it might be of conſiderable importance in ſome of the arts.

Sect. XIII. *Of Mercury and its Combinations.*

1700 Hiſtory. 1. Mercury appears to have been known from the earlieſt ages. By comparing its properties with ſilver, and being in the fluid ſtate, it has been called *quickſilver*. Mercury was long the ſubject of the reſearches of the alchemiſts, with the view of diſcovering the method of tranſmuting it into gold or ſilver. It was ſuppoſed to approach ſo near to theſe metals, particularly to the latter, in its nature, that all that was wanted for this tranſmutation, was to fix it, or to bring it to the ſolid ſtate. In conſequence of the numerous experiments to which it was ſubjected, and the great variety of forms it aſſumed, they regarded it as the principle of all other bodies, and one of the elements of nature. It was ſuppoſed to exiſt in all metals, and alſo to form one of the component parts of many bodies. Hence, according to this theory, there were two kinds of mercury; the one the principle of a great number of bodies, and the other common mercury, or the metal known by that name. Hence, according to Beccher, it was called *the mercurial principle*, or *the mercurial earth*. But however extravagant the reſearches of the alchemiſts may now be conſidered to have been, it is to their labours that chemiſtry is indebted for the knowledge of many important properties and combinations of this metal.

1701 Ores. 2. Mercury is found in four different ſtates. In the metallic ſtate, alloyed with other metals, combined with ſulphur, and with muriatic acid. 1. Native or virgin mercury is found in the cavities or clefts of rocks, in ſtrata of clay, or of chalk, in the form of liquid globules, which are eaſily diſtinguiſhed by their brilliancy. 2. It is found more frequently alloyed with other metals, or, as it is called when mercury is combined with a metal, *amalgamated*, and moſt frequently with ſilver. 3. A frequent ore of mercury is the red ſulphuret, which is known by the name of *cinnabar*. The ſulphuret of mercury is of various colours, from vermilion red to brown. Sometimes it effloreſces on the ſurface of the ore, when it is called *flowers of cinnabar*, or *native vermilion*. 4. The fourth ore of this metal is the muriate. This ſalt is white and brilliant, and of a lamellated ſtructure.

1702 Analyſis. 3. Native mercury is frequently alloyed with other metals; it is therefore of importance to be able to aſcertain the proportions. For this purpoſe it is to be diſſolved in nitric acid. If it contain gold, this metal remains in a ſtate of powder at the bottom of the veſſel. If alloyed with biſmuth, it may be precipitated with water, which does not ſeparate the oxide of mercury. Silver is detected by precipitating the ſolution by means of muriate of ſoda. The muriate of ſilver and the muriate of mercury fall down together; but the latter being more ſoluble in water than the former, may be eaſily ſeparated.

The ſulphuret of mercury may be decompoſed by boiling it with eight times its weight, of a mixture of three parts of nitric, and one of muriatic acid; the metallic part is diſſolved, and the ſulphur remains in the ſtate of powder.

1703 To diſcover its purity. It may be known whether mercury has been adulterated with other metals, by its dull and leſs brilliant luſtre, and by its ſoiling the hands, or white bodies on which it is rubbed, and by its dividing with more difficulty into round globules, which appear flat and uneven, adhere to the veſſels in which they are agitated, and when poured along a ſmooth ſurface, by their *dragging* a tail. Mercury is alſo impure, when the globules do not readily run together, and when it is agitated with water, ſeparating from it a black powder.

1704 Purification. To procure mercury in a ſtate of purity, or to revive it, as it is called, two parts of cinnabar and one of filings of iron are well triturated together, and diſtilled in an iron retort, introducing the beak of the retort into a receiver, with water. The iron has a greater affinity for the oxygen and the ſulphur of the mercury than the latter. The mercury, therefore, riſes in vapour, and is condenſed by the water. There remains in the retort a ſulphuret of iron, in which the metal is a little oxidated. The mercury thus obtained, being dried and paſſed through a ſkin, is very pure and brilliant.

1705 Properties. 4. Mercury is of a white colour, is one of the moſt brilliant of the metals, and when its ſurface is clean and not tarniſhed, makes a good mirror. Next to gold, platina, and tungſten, it is the heavieſt of the metals; its ſpecific gravity is 13.568. It has no perceptible taſte or ſmell.

5. At the ordinary temperature of the atmoſphere mercury is always in the liquid ſtate; but when it is expoſed to a degree of cold equal to −39° it becomes ſolid. This was firſt diſcovered in the year 1759 by the academicians of Peterſburgh. Similar experiments have ſince been frequently repeated. In 1772, Pallas ſucceeded in the congelation of mercury at Kraſnojark, by a natural cold equal to −55½° Fahrenheit. Mercury was alſo congealed by a natural cold in 1775 at Hudſon's bay. The freezing of mercury is now a common experiment by means of artificial cold, and the method of producing this has been already deſcribed, in treating of freezing mixtures. In ſome experiments which have been made on the congelation of mercury, it was remarked, that a ſlight ſhock was communicated to the perſon who held the tube containing the metal, by its ſudden contraction at the moment it became ſolid. Mercury cryſtallizes in very ſmall octahedrons. It appears to be malleable, for by ſtriking it with a hammer in the ſolid ſtate, it was flattened and extended.

1706 Action of heat. 6. At the temperature of 660° mercury boils, and is then converted into vapour. This vapour, like common air, is inviſible and elaſtic. When mercury is expoſed to the air, the ſurface becomes tarniſhed, and is covered with a black powder. 1707 Oxides. This change is owing to the abſorption of the oxygen of the air, and the converſion of the mercury into an oxide. This proceſs is generally promoted by applying heat to the mercury, or by ſhaking it, ſo that it may be brought in contact with the air. 1708 Black. To this black powder, which is the firſt degree of the oxidation of the metal, the name of *ethiops per ſe* was formerly given, becauſe it is obtained without the aſſiſtance of any other ſubſtance. According to Fourcroy, this oxide contains

Mercury,	96
Oxygen,	4
	100

By

1709 Red. By a ſtrong heat the oxygen is driven off, and the mercury is reduced to the metallic ſtate: but when this oxide is expoſed to a more moderate degree of heat, it combines with more oxygen, and is converted into the red oxide, ſo called from its colour. This oxide may alſo be obtained, by expoſing a quantity of mercury for ſome length of time in a veſſel provided with a long narrow neck, by which means the vapours of the mercury are prevented from eſcaping, while the air is admitted. By this proceſs the mercury is alſo converted into the red oxide; and, obtained in this way, it was formerly called *precipitate per ſe*, or *red precipitate*. This oxide may alſo be obtained by diſſolving mercury in nitric acid, evaporating to dryneſs, and expoſing the maſs to a very ſtrong heat, to drive off the acid. What remains being reduced to powder, is the red oxide of mercury, or red precipitate. This oxide, according to Fourcroy, contains one-tenth of its weight of oxygen. It is of an acrid diſagreeable taſte, and has ſo powerful an effect upon animal matters, that it may be conſidered as a poiſon. It corrodes the ſkin with which it comes in contact. When this oxide is expoſed to heat, it is decompoſed; part of its oxygen is given out, and it is converted into the black oxide. Even by expoſure to the light of the ſun, this change is effected, as it paſſes through different ſhades of colour.

1710 Action of hydrogen. 7. Mercury does not enter into combination with azote, hydrogen, or carbone; but if hydrogen gas be kept in contact with the red oxide, it is gradually converted into the black oxide. If hydrogen gas be made to paſs through a tube heated to redneſs, containing red oxide of mercury, a detonation takes place. The oxygen and hydrogen combine together to form water, while the mercury is reduced to the metallic ſtate. This oxide may be alſo reduced by means of charcoal, with the aſſiſtance of heat. The oxygen of the oxide combines with carbone, and forms carbonic acid, and the mercury is revived.

1711 Phoſphuret. 8. Phoſphorus combines with mercury with difficulty. Pelletier took equal parts of phoſphorus and red oxide of mercury, and introduced them into a matraſs, to which he added a little water, to cover the mixture. It was expoſed to the heat of a ſand bath, and agitated from time to time. The oxide ſoon became black, and united to the phoſphorus. The water retained phoſphoric acid; ſo that it appears to be a compound of phoſphorus and the black oxide of mercury. The phoſphuret of mercury, thus formed, becomes ſoft in boiling water, and acquires ſome conſiſtence in the cold. When it is heated, it is decompoſed. The phoſphorus and the mercury are ſeparately emitted. Expoſed to a dry air, it diffuſes white vapours, which have the odour of phoſphorus.

1712 Sulphuret. 9. Mercury combines readily with ſulphur, either by ſimple trituration in the cold, or by the action of heat. One part of mercury and two of ſulphur, triturated together in a mortar, the mercury ſoon diſappearing, form a black powder, which was formerly diſtinguiſhed by the name of *ethiops mineral*. Fourcroy is of opinion, that in this proceſs the mercury is oxidated, and the ſulphur is combined with the black oxide; in ſupport of which, he ſtates that the ſulphur cannot be ſeparated from the mercury, but by ſome chemical action. Berthollet ſuppoſes that this ſubſtance contains ſulphurated hydrogen; and hence it is concluded that *ethiops mineral* is a hydrogenous ſulphuret of mercury, compoſed of mercury, ſulphur, and ſulphurated hydrogen.

1713 Cinnabar. When this compound is heated in an open veſſel, the ſulphur, which is in a ſtate of minute diviſion, takes fire, and is ſoon reduced to ſulphurous acid gas. The mercury is at the ſame time more ſtrongly oxidated; is converted to a deep violet-coloured powder; and if in this ſtate it be heated in a maſs, it is ſublimed in the form of a deep red cake, of a brilliant, cryſtalline appearance. This ſubſtance was formerly called *artificial cinnabar*, or, in the preſent language of chemiſtry, *red ſulphurated oxide of mercury*. Various proceſſes have been given for the preparation of this ſubſtance. Seven parts of mercury ſqueezed through leather to purify it, are to be fuſed with one part of ſulphur in an earthen veſſel, agitating the mixture till it is completely reduced to the black ſulphurated oxide. Introduce this into a matraſs, placed in a crucible furniſhed with ſand, and expoſe it gradually to the heat of a furnace, which is to be increaſed till the matter is ſublimed, and collected at the top of the veſſel. It is then removed, and when the veſſel is broken, a red maſs is obtained, with a degree of beauty and brilliancy in proportion to the temperature which has been employed, and the ſmall quantity of ſulphur which it retains. Fourcroy conſiders this as a compound of ſulphur and the red oxide of mercury: but according to Prouſt, it is a ſulphuret of mercury; that is, a compound of ſulphur and metallic mercury. Its component parts are,

Mercury	85
Sulphur	15
	100

1714 Properties. This ſulphuret is of a fine ſcarlet colour. It is not altered by expoſure to the air, and is inſoluble in water. The ſpecific gravity is 10. When a ſufficient degree of heat is applied to it, it takes fire, and burns with a blue flame. When reduced to powder, it is then called vermilion, which is well known as a paint. 1715 Vermilion.

1716 Affinities. 10. The order of the affinities of mercury is the following:

Mercury.	Oxide of Mercury.
Gold,	Muriatic acid,
Silver,	Oxalic,
Tin,	Succinic,
Lead,	Arſenic,
Biſmuth,	Phoſphoric,
Platina,	Sulphuric,
Zinc,	Saclactic,
Copper,	Tartaric,
Antimony,	Citric,
Arſenic,	Sulphurous,
Iron.	Nitric,
	Fluoric,
	Acetic,
	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Mercury.

1. Sulphate of Mercury.

1717 Different ſulphates.

1. Sulphuric acid forms ſalts with the different oxides of mercury, and with different proportions of theſe oxides, ſo that there is a conſiderable variety of the ſulphates of mercury. This ſeems to depend on the nature of the action between ſulphuric acid and mercury, according to the temperature in which the combination is made, and the quantity of acid employed.

1718 Preparation.

2. Sulphuric acid has no effect on mercury in the cold; but if two parts of mercury and three of ſulphuric acid be introduced into a retort, and expoſed to heat, an efferveſcence takes place, with the evolution of ſulphurous acid gas. If the proceſs be ſtopped, when the mercury is converted into a white maſs, and there yet remains part of the liquid, it is found to be acrid and corroſive, and it reddens vegetable blues. This is the ſulphate of mercury with exceſs of acid. This acidulous ſulphate of mercury contains very different proportions of ſulphuric acid, according to the original quantity employed. If this ſulphate be waſhed with a ſmaller quantity of water than is neceſſary for its complete ſolution, and if this be repeated till the water no longer changes vegetable blues, there remains a white ſalt without acidity, and which is much leſs acrid and corroſive than the ſaline maſs from which it is obtained. This may be conſidered as a neutral ſulphate of mercury.

1719 Properties.

3. It is of a white colour, cryſtallizes in plates, and in fine, needle-ſhaped priſms. The taſte is not acrid. It is ſoluble in 500 parts of cold water, and in one half that quantity of boiling water. When cryſtallized, it is compoſed of

Mercury	75
Oxygen	8
Sulphuric acid	12
Water	5
	100

It is ſoluble both in cold and hot water, without being decompoſed. The pure alkalies and lime water, occaſion a precipitate of a grayiſh-black powder. When ſulphuric acid is added, it is then reduced to the ſtate of acidulous ſulphate, and its ſolubility increaſes in proportion to the additional quantity of acid. A twelfth part of acid renders it ſoluble in 157 parts of cold water, and in 33 of boiling water. But if $\frac{1}{4}$ of this quantity of cold water be added, it combines with the whole exceſs of acid, and forming a liquid of greater denſity than when it is diluted with 157 parts of water neceſſary for its complete ſolution, it diſſolves much more of the ſulphate of mercury, and brings the ſalt to a ſtate of greater acidity. In then requires 500 parts of water for its ſolution.

1720 A different ſalt by continuing the heat.

4. But if the ſame proportions of ſulphuric acid and mercury, namely, three parts of acid, and two of mercury, be expoſed for a longer time to the action of heat, a greater proportion of ſulphuric acid is decompoſed, and the mercury combines with a greater proportion of oxygen. The ſalt thus obtained, poſſeſſes different properties from the former. It cryſtallizes in ſmall priſms, and when it is neutralized, it is of a dirty-white colour; but if it be obtained in the dry ſtate, it is pure white, and in this ſtate it is combined with an exceſs of acid. It is then deliqueſcent in the air; but, in the neutral ſtate, it undergoes no change. When hot water is added to this ſalt, it is converted into a yellow powder, which has been long diſtinguiſhed by the name of *turpeth mineral*.

5. It was formerly ſuppoſed that turpeth mineral, which is obtained by the addition of warm water to this ſalt, was a ſimple oxide of mercury, without any portion of ſulphuric acid. Fourcroy mentions, that Rouelle firſt conjectured, that it was combined with a certain portion of the acid, and that his experiments have verified and confirmed this conjecture: for in treating turpeth mineral, after being well waſhed with muriatic acid, this ſolution precipitates by means of muriate of barytes, a ſulphate of barytes from this baſe. Fourcroy denominates this ſalt *ſulphate of mercury with exceſs of acid*, or *yellow ſulphate of mercury*. It is ſoluble in 600 parts of boiling water; but another ſulphate of mercury remains in the ſolution. This contains an exceſs of acid, and is therefore more ſoluble in water.

1721 Three ſulphates.

1722 Acidulous ſulphate.

1723 Subſulphate.

6. From a ſeries of experiments which Fourcroy made on this ſubject, he concludes, that there are three diſtinct ſulphates of mercury. 1. The firſt is the neutral ſulphate of mercury, which cryſtallizes, is ſoluble in 500 parts of cold water, and forms a copious precipitate with the alkalies, which is not decompoſed by nitric acid, but forms a mild muriate of mercury with the addition of muriatic acid. 2. The acidulous ſulphate of mercury, which is more ſoluble than the former, is precipitated of an orange colour by means of the alkalies. The exceſs of acid is removed, and alſo a portion of the ſalt, with $\frac{1}{4}$ of the water neceſſary for its complete ſolution. The neutral ſulphate of mercury remains behind, and is not decompoſed by means of nitric acid. 3. The third ſulphate of mercury contains an exceſs of baſe, or of the oxide of mercury. It is of a yellow colour, ſoluble in 200 parts of water, and is precipitated of a gray colour by the alkalies. It is decompoſed by nitric acid; and muriatic acid converts it into a hyperoxymuriate of mercury.

2. Sulphate of Ammonia and Mercury.

1724 Preparation.

1725 Properties.

1726 Compoſition.

This triple ſalt is formed by adding ammonia to a ſolution of neutral ſulphate of mercury. A copious gray precipitate is thrown down, which, being expoſed to the light of the ſun, is partly reduced to the metallic ſtate, and partly to that of a gray powder. This laſt is the ſulphate of ammonia and mercury. It is ſoluble in ammonia; and by evaporation, brilliant polygonal cryſtals are formed. Or, if a large quantity of water be added to the ſolution, it becomes white and milky, and there is precipitated the ſame ſalt, but without any regular form. This ſalt has a pungent, auſtere taſte. When it is heated, it gives out ammonia, azotic gas, a ſmall quantity of metallic mercury, and a little ſulphite of ammonia. There remains in the retort yellow ſulphate of mercury. According to the analyſis of Fourcroy, this triple ſalt is compoſed of

Sulphuric acid	18
Mercury	39
Ammonia	33
Water	10
	100

3. Nitrate of Mercury.

1727 Preparation.

1. Nitric acid is rapidly decompoſed by mercury. It is accompanied with efferveſcence, and the evolution of nitrous gas. The mercury combines with part of the oxygen of the acid; it is thus oxidated, and is then diſſolved in the remaining portion of the acid. This ſolution of mercury in nitric acid, when it is made in the cold, is colourleſs, very heavy, and ſo extremely cauſtic, that it has been employed as an eſcharotic, under the name of *mercurial water*. It produces an indelible browniſh black ſpot on all animal and vegetable ſubſtances. By ſpontaneous evaporation it affords regular tranſparent cryſtals, compoſed of two four-ſided pyramids, truncated near their baſes, and on the four angles which reſult from the union of the pyramids. But different cryſtals are formed, according to the nature of the ſolution, and the evaporation, whether it has been more ſlowly or more rapidly conducted. When this ſolution of mercury in nitric acid is made in the cold, the compound formed is a nitrate of mercury without exceſs of the oxide or baſe; but if mercury be added to this ſolution, and the action be aided by heat, a new portion of the oxide is diſſolved. It is then a nitrate of mercury with exceſs of baſe. 1728 Three nitrates. Fourcroy diſtinguiſhes three nitrates of mercury. 1. Nitrate of mercury neutralized. From this regular cryſtals are obtained, and it is not precipitated by water. 2. The acidulous nitrate of mercury, or with exceſs of acid. This is obtained by diſſolving the firſt in water containing nitric acid, or by adding this acid to the other nitrates. 3. The nitrate of mercury with exceſs of oxide. This exiſts in the ſolution precipitated by water, or by expoſing the other nitrates to the action of heat. In this way is produced what was formerly called *nitrous turpeth*.

2. Theſe different nitrates of mercury poſſeſs many common properties, but are ſufficiently diſtinguiſhed by others, and particularly by their decompoſition. When the nitrate of mercury is placed upon burning coals, it detonates feebly, although with a vivid white flame, when it has been ſufficiently dried; but when it is moiſt it melts, blackens, extinguiſhes that part of the coal which it touches, and throws out ſmall red ſparks, with a ſlight decrepitation about the dried edges of the maſs. The nitrate of mercury with exceſs of oxide poſſeſſes a ſtill more feeble detonating property. The nitrate of mercury with exceſs of acid boils up, melts very rapidly, ſwells greatly, and exhales red vapours, with very little detonation. If the nitrate of mercury, neutralized, be heated in a crucible without any combuſtible matter, it melts, exhales nitrous gas, becomes of a deep yellow colour, then paſſes to an orange, and at laſt is converted into a deep red. In this ſtate it was formerly called *red precipitate*. It is the red oxide of mercury, which is obtained by the decompoſition of the nitrate.

3. The pure nitrate of mercury expoſed to the air in the ſtate of cryſtals, is ſoon changed. It gradually abſorbs oxygen from the atmoſphere, and paſſes from a white to a yellow colour. This is the *nitrous turpeth*. It is a yellow oxide of mercury combined with a ſmall portion of nitric acid, or a nitrate of mercury with exceſs of baſe. The yellow colour becomes deeper with the addition of boiling water. The nitrous turpeth, it has been obſerved, contains a greater quantity of oxygen than that which is prepared by ſulphuric acid, and from this circumſtance it is more readily converted into red oxide by the action of heat.

1729 Decompoſition.

4. The nitrate of mercury is decompoſed by all the alkalies, but with different phenomena, according to the ſtate of the combination, and particularly the degree of oxidation of the baſe. Bergman has diſtinguiſhed the two ſolutions of mercury, that which is not precipitated by water, from that which is precipitated by the different products which are obtained by means of alkalies. The nitrate of mercury affords with potaſh, a yellowiſh white oxide; with carbonate of potaſh, a white oxide; and with ammonia, an oxide of a dark gray colour. Sulphuric acid and the ſulphates occaſion a precipitate in form of a white powder. Muriatic acid and the muriates give a thick maſs reſembling curd. But the ſolution which is precipitated by water, and which is more acrid, and leſs diſpoſed to cryſtallize, affords precipitates by means of the fixed alkalies, of a deeper yellow or brown colour. By means of ammonia, a white precipitate is formed; by means of the ſulphuric acid and the ſulphates, a yellow precipitate, and by the muriatic acid, a more copious, curdled matter. Fourcroy has obſerved in the decompoſition of nitrate of mercury with exceſs of acid, that a precipitate in the ſtate of black powder is formed, with a great addition of the alkali; but if it be added in ſmall quantity, the precipitate is white or gray. A copious precipitate is obtained, from the clear ſupernatant ſolution, by diluting it with water. The ſame white precipitate is obtained, by mixing together nitrate of mercury and nitrate of ammonia. By evaporating the liquid, which is rendered turbid by the addition of water, ſix-ſided priſmatic cryſtals are depoſited, as the ammonia is volatilized. The white precipitate is a brittle ſalt, which has very little ſolubility, having an exceſs of oxide, of mercury, and ammonia. 1730 Compoſition. The component parts of this ſalt, according to Fourcroy are,

Acid and water	15.80
Oxide of mercury,	68.20
Ammonia	16.00
	100.00

1731 Howard's fulminating powder.

5. From a ſolution of mercury in nitric acid, Mr Howard prepared a fulminating powder poſſeſſed of peculiar properties; the proceſs which he found to anſwer beſt, is the following:

1732 Preparation.

"One hundred grains, or a greater proportional quantity, of quickſilver (not exceeding 500 grains) are to be diſſolved, with heat, in a meaſured ounce and a half of nitric acid. This ſolution being poured cold upon two meaſured ounces of alcohol, previouſly introduced into any convenient glaſs veſſel, a moderate heat is to be applied until an efferveſcence is excited. A white fume then begins to undulate on the ſurface of the liquor; and the powder will be gradually precipitated upon the ceſſation of action and re-action. The precipitate is to be immediately collected on a filter, well waſhed with diſtilled water, and carefully dried in a heat not much exceeding that of a water bath. The immediate edulcoration of the powder is material, becauſe it is liable to the re-action of the nitric acid; and, whilſt any of that acid adheres to it, it is very ſubject to the influence of light. Let it alſo be cautiouſly remembered, that the mercurial ſolution is to be poured upon the alcohol.

"I have recommended quickſilver to be uſed in preference to an oxide, becauſe it ſeems to anſwer equally, and is leſs expenſive; otherwiſe, not only the pure red oxide, but the red nitrous oxide and turpeth may be ſubſtituted; neither does it ſeem eſſential to attend to the preciſe ſpecific gravity of the acid or the alcohol. The rectified ſpirit of wine and the nitrous acid of commerce never failed, with me, to produce a fulminating mercury. It is indeed true, that the powder prepared without attention, is produced in different quantities, varies in colour, and probably in ſtrength. From analogy, I am diſpoſed to think the whiteſt is the ſtrongeſt; for it is well known, that black precipitates of mercury approach the neareſt to the metallic ſtate. The variation in quantity is remarkable; the ſmalleſt quantity I ever obtained from 100 grains of quickſilver being 120 grains, and the largeſt 132 grains. Much depends on very minute circumſtances. The greateſt product ſeems to be obtained, when a veſſel is uſed which condenſes and cauſes moſt ether to return into the mother liquor; beſides which, care is to be had in applying the requiſite heat, that a ſpeedy and not a violent action be effected. One hundred grains of an oxide are not ſo productive as 100 grains of quickſilver.

1733 Properties.

This powder, ſtruck on an anvil with a hammer, explodes with a ſtunning diſagreeable noiſe, and with ſuch force, as to indent both the hammer and the anvil. Half a grain or a grain, if quite dry, is as much as ought to be uſed on ſuch an occaſion. The ſhock of an electric battery, ſent through five or ſix grains, produces a very ſimilar effect. The powder explodes at the 368th degree of Fahrenheit's thermometer. A quantity of it, ſufficient to diſcharge a bullet from a gun, with a greater force than an ordinary charge of gunpowder, always burſts the piece. Ten grains of the powder, exploded in a glaſs globe, produce only four cubic inches of air, conſiſting of carbonic acid gas and nitrogene, or azotic gas.

1734 Decompoſition.

1735 Compoſition.

This powder is decompoſed by ſulphuric, nitric, and muriatic acids. When concentrated ſulphuric acid is poured upon it, an immediate exploſion takes place. According to the experiments of Mr Howard, this powder conſiſts of oxalate of mercury, and nitrous etheriſed gas. But it appears that the nature of the component parts varies with the different modes which are followed in its preparation. When it is prepared with little heat, it conſiſts of nitric acid, oxide of mercury, and a peculiar vegetable ſubſtance; but by continuing the heat during the fermentation, a greeniſh colour is communicated to the powder. It is then found to be compoſed of ammonia, oxide of mercury, and a greater proportion of the vegetable matter. Its detonating power is more feeble, and it gives out a blue flame when placed on hot coals. By boiling the mixture for half an hour, it is compoſed of oxalate of mercury, and a ſmall proportion of vegetable matter; does not detonate, but decrepitates when it is heated *.

4. Muriate of Mercury.

1736 This compound long known.

1. Muriatic acid has no action whatever on mercury; but it combines readily with its oxides, and forms ſalts which have been the ſubject of reſearch among chemiſts, almoſt in every age. The muriates of mercury were known to the Arabians in the 10th and 11th centuries. They were the firſt objects of ſtudy and examination with the alchemiſts, in their ſearch after the philoſophers ſtone; and ſince chemiſtry aſſumed the form of a ſcience, they have greatly occupied the attention of philoſophers, in diſcovering their nature and properties.

1737 Two muriates.

2. There are two compounds of muriatic acid and the oxides of mercury, which poſſeſs very different properties, according to the degree of oxidation of the mercury.

1738 Preparation.

3. Muriatic acid precipitates the oxides of mercury from their ſolutions in ſulphuric and nitric acids. If muriatic acid be added to the yellow ſulphate of mercury, or to the nitrate of mercury which is precipitable by water, a muriate of mercury is obtained, which is ſoluble in water, and which, on account of its properties, was formerly called *corroſive ſublimate*, or *corroſive muriate of mercury*. But if muriatic acid be added to the acidulous ſulphate of mercury, or to the nitrate of mercury which affords no precipitate with water, a white, inſoluble, inſipid precipitate is obtained, which was formerly called *ſweet mercury* or *calomel*, and is now known by the name of *ſubmuriate*, and ſometimes *ſweet muriate of mercury*.

1739 Of the muriate.

4. The muriate of mercury, or corroſive ſublimate, may be prepared by the following proceſs. Boil two parts of mercury with two and a half of ſulphuric acid in a matraſs, with the heat of a ſand bath, to dryneſs. Let this dry maſs be mixed with four parts of dried muriate of ſoda, and let the whole be ſublimed in a glaſs veſſel, by gradually increaſing the heat. In the firſt part of this proceſs, part of the ſulphuric acid is decompoſed; the mercury combines with the oxygen and forms an oxide, which is diſſolved in the undecompoſed part of the ſulphuric acid, and a ſulphate of mercury is thus obtained. The muriate of ſoda being mixed with this ſalt, produces another decompoſition. The muriatic acid combines with the mercury, forming the muriate of mercury, which is ſublimed; and the ſulphuric acid of the ſulphate of mercury combines with the ſoda, forming a ſulphate of ſoda, which remains behind.

1740 Properties.

5. The muriate of mercury thus obtained, forms a beautiful white, ſemitranſparent maſs, which is found to be compoſed of ſmall priſmatic cryſtals in the form of needles. It may be obtained by evaporation, in the form of cubes or rhomboidal priſms, or four-ſided priſms, having the alternate ſides narrower, and terminated by two-ſided ſummits. The taſte is extremely acrid and cauſtic, and the metallic impreſſion remains long on the tongue. The ſpecific gravity is 5.1398. It is ſoluble in 20 parts of cold water, and in leſs weight of boiling water. This ſalt is not altered by expoſure

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* Phil. Tranſ. 1800.

to the air; and, when it is ſublimed by heat, it remains unchanged. It is ſoluble in ſulphuric, nitric, and muriatic acids, and, when theſe ſolutions are evaporated, the muriate of mercury is obtained unaltered. It is precipitated by all the alkalies and earths, of an orange-yellow colour, which gradually changes to a brick-red. The carbonates of the fixed alkalies afford a permanent yellow colour. Ammonia forms with it a triple ſalt. The component parts of this ſalt, according to Mr Chenevix, are,

1741 Compoſition.

Oxide of mercury	82
Acid	18
	100

Muriate of mercury is one of the moſt violent poiſons known. When taken internally, it produces nauſea and vomiting, with ſevere pain, and, in a ſhort time, corrodes the ſtomach and bowels. Externally, it is employed as an eſcharotic for deſtroying fungous fleſh. It ſublimes readily when heated, and is extremely injurious in the ſtate of vapour, to thoſe who breathe it.

1742 Preparation. *Submuriate of Mercury.*—This ſalt is prepared by triturating together in a glaſs mortar, four parts of muriate of mercury or corroſive ſublimate, with three of mercury, till the latter diſappear. When this is formed into an uniform maſs, it is put into a matraſs, of which it ſhould fill $\frac{1}{3}$, and it is to be ſublimed with the heat of a ſand bath. When the proceſs is finiſhed, the phial is broken; and the white matter at the upper part of the veſſel, and the red matter at the bottom, are to be ſeparated, and the remaining part of the maſs is to be ſublimed, and afterwards reduced to a fine powder, which is to be well waſhed with boiling water.

In this proceſs, it is obvious, that the mercury which is added, combines with part of the oxygen of the oxide of mercury, formerly combined with the muriatic acid; and the whole of the oxide of mercury having now a ſmaller proportion of oxygen, is combined with a ſmaller proportion of muriatic acid. This will appear from the proportions of its component parts, as they have been aſcertained by Mr Chenevix.

1743 Compoſition. Oxide of mercury in calomel contains.

Mercury	89.3
Oxygen	10.7
	100.0

Calomel is compoſed of

Oxide of mercury	88.5
Muriatic acid	11.5
	100.0

1744 Properties. Submuriate of mercury, or calomel, is generally in the form of a white, ſolid maſs; but it is ſuſceptible of cryſtallization in four-ſided priſms, terminated by pyramids. It has ſcarcely any taſte, has no poiſonous property, and is very little ſoluble in water. The ſpecific gravity is 7.1758. It becomes dark coloured by expoſure to light, is phoſphoreſcent when rubbed in the dark, and requires a higher temperature for its ſublimation than the muriate of mercury. It is converted into muriate or corroſive ſublimate, by the nitric and oxymuriatic acids.

1745 Different names. This ſalt, which is now generally known in the ſhops, by the name of *calomel* or *ſweet mercury*, was formerly deſcribed under a great variety of names, derived from its effects, or the mode of its preparation. In the beginning of the 17th century, it was regarded as an important ſecret. But, in the year 1608, Beguin deſcribed it very accurately, in his *tyrocinium chemicum*, under the name of *the dragon tamed*, on account of the corroſive ſublimate from which it was prepared, being deprived of its poiſonous and deſtructive qualities. At different periods it was diſtinguiſhed by other names, as *aquila alba*, *aquila mitigata*, *manna metallorum*, *panchymagogus quercitanus*, &c. The uſe of this ſalt as a purgative, and indeed in all caſes where mercurial preparations are required, is well known.

5. Muriate of Ammonia and Mercury.

1746 Preparation. If ammonia be added to a ſolution of muriate of mercury, or corroſive ſublimate, a white precipitate is obtained, which is a triple ſalt, formed by the combination of the ammonia with the muriate of mercury. This white precipitate has at firſt an earthy taſte, which becomes afterwards metallic and diſagreeable. It ſeems to be inſoluble in water. Sulphuric acid forms with this triple ſalt, corroſive ſublimate, and ſulphate of ammonia and mercury. Nitric acid converts it into a corroſive ſublimate and nitrate of ammonia and mercury. It is completely ſoluble in muriatic acid, and there is formed a muriate of mercury and ammonia. This preparation was known to the alchemiſts, and diſtinguiſhed by the names of *ſal alembroth*, and *ſalt of wiſdom*. The component parts of this ſalt, according to Fourcroy, are

Acid,	16
Oxide of mercury,	81
Ammonia,	3
	100 *

6. Hyperoxymuriate of Mercury.

1747 Preparation. The ſalt was formed by Mr Chenevix, by paſſing a current of oxymuriatic acid gas through water, in which there was red oxide of mercury. The oxide became of a dark brown colour, and a ſolution appeared to have taken place. The liquor was evaporated to dryneſs, and a ſalt was obtained which conſiſted partly of corroſive ſublimate, and partly of hyperoxymuriate of mercury. By ſeparating the latter, and cryſtallizing it again, it was obtained nearly pure. 1748 Properties. This ſalt is more ſoluble than corroſive ſublimate, four parts of water retaining it in ſolution. Hyperoxymuriatic acid is given out by the addition of ſulphuric, or even weaker acids, and the liquid aſſumes an orange colour †.

7. Fluate of Mercury.

Fluoric acid combines only with the oxide of mercury; or the ſoluble fluates mixed with a ſolution of nitrate of mercury, produce a precipitate of a white colour, which is the fluate of mercury, of which the properties are little known.

8. Borate

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* *Fourcroy*, v. 309—342.

† *Phil. Tranſ.* 1802, p. 260.

8. Borate of Mercury.

Boracic acid has no direct action on mercury, but by mixing together a ſolution of borate of ſoda with a ſolution of nitrate of mercury, a yellowiſh precipitate is obtained, which is the borate of mercury. This ſalt acquires a greeniſh colour by expoſure to the air. Lime water forms a precipitate of a red powder.

9. Phoſphate of Mercury.

Phoſphoric acid has no action on mercury, but it combines with its oxide. This ſalt may be prepared by precipitating the nitrate of mercury in ſolution, by means of phoſphate of ſoda. A white precipitate is formed, which is a phoſphate of mercury. This ſalt is inſoluble in water, phoſphoreſces when rubbed in the dark, and is decompoſed by heat, giving out phoſphorus.

10. Carbonate of Mercury.

By precipitating the ſolutions of mercury in the other acids by means of the alkaline carbonates, a white precipitate is obtained, which is a carbonate of mercury.

11. Arſeniate of Mercury.

When arſenic acid is diſtilled in a retort with mercury, it is partially decompoſed. Arſenious acid is ſublimed, with a portion of metallic mercury and a ſmall quantity of yellow oxide. There remains behind a yellow maſs, which is arſeniate of mercury. It is inſoluble in water, and in ſulphuric and nitric acids. It is ſoluble in muriatic acid, and affords by evaporation and ſublimation, the muriate of mercury, or corroſive ſublimate. Arſenic acid precipitates the ſulphate and nitrate of mercury in the form of a white powder, which is alſo arſeniate of mercury.

12. Tungſtate of Mercury.

This ſalt is formed by adding to a ſolution of nitrate of mercury, an alkaline tungſtate. The ſalt is decompoſed, and the tungſtate of mercury is precipitated in the form of a white inſoluble powder.

13. Molybdate of Mercury.

Molybdic acid precipitates mercury from its ſolution in nitric acid, in the form of a white flaky powder. It is alſo inſoluble in water.

14. Chromate of Mercury.

An alkaline chromate in ſolution, added to a ſolution of nitrate of mercury, forms a precipitate of a fine reddiſh purple colour. This is the chromate of mercury, which is inſoluble in water, and which Vauquelin, who diſcovered it, ſuggeſts to be employed as a pigment.

15. Columbate of Mercury.

Unknown.

16. Acetate of Mercury.

749 Combines with two oxides.

1. Acetic acid combines with the oxides of mercury, and forms different ſalts, according to the oxide which enters into the combination. With the red oxide of mercury it forms a ſalt which does not cryſtallize; but when the liquid is concentrated, and evaporated to dryneſs, it affords a yellow deliqueſcent maſs. When this ſalt is diſſolved in water, it divides into two parts; the one falls down in the ſtate of yellow powder, which is acetate of mercury with exceſs of baſe; and the other part remains in ſolution, becauſe it contains an exceſs of acid.

2. But when nitrate of mercury is precipitated by means of alkalies, and the precipitate is diſſolved in acetic acid, the ſolution yields by evaporation and cooling, acetate of mercury, in thin brilliant flakes. The ſalt may alſo be formed by mixing together ſolutions of acetate of potaſh and nitrate of mercury. The acetate of mercury appears in the form of large flat cryſtals, which have an acrid taſte, and are ſcarcely ſoluble in water. This latter ſalt is a compound of acetic acid and the oxide of mercury, with a ſmaller proportion of oxygen. It is employed in medicine, and forms the principal ingredient of *Keyſer's pills*.

17. Oxide of Mercury.

Oxalic acid combines with the oxide of mercury, and forms an oxalate in the ſtate of white powder, which is ſcarcely ſoluble in water. It becomes black by expoſure to the light. When it is heated it detonates. This ſalt may alſo be obtained, by adding oxalic acid to a ſolution of the nitrate or ſulphate of mercury.

18. Tartrate of Mercury.

Tartaric acid forms an inſoluble ſalt of a white colour, with the oxide of mercury, which becomes yellow by expoſure to the light.

19. Tartrate of Potaſh and Mercury.

This triple ſalt may be prepared by boiling together in water, one part of oxide of mercury, and ſix of tartar. Cryſtals of the triple ſalt are obtained by evaporating the liquid.

20. Citrate of Mercury.

Citric acid produces an efferveſcence with the red oxide of mercury, changes into a white colour, and then unites it in one maſs. This ſalt is ſcarcely ſoluble in water. It has a metallic taſte, and is decompoſed by nitric acid.

21. Malate of Mercury.

When malic acid is added to a ſolution of nitrate of mercury, a white precipitate is formed, which is malate of mercury.

22. Benzoate of Mercury.

Benzoic acid forms with the oxide of mercury, a ſalt in the ſtate of white powder, which is inſoluble in water, and is ſcarcely altered by expoſure to the air. It is decompoſed by heat.

23. Succinate of Mercury.

Succinic acid combines with the oxide of mercury with the aſſiſtance of heat, and forms with it an irregular maſs in which ſome cryſtals are obſerved.

24. Saccolate of Mercury.

By adding ſaclactic acid to a ſolution of nitrate of mercury, a white precipitate is formed, which is ſaccolate of mercury.

25. Mellate of Mercury.

Mellitic acid added to a ſolution of nitrate of mercury, produces a copious precipitate, which is re-diſſolved by the addition of nitric acid *.

26. Pruſſiate of Mercury.

This ſalt is obtained by boiling the red oxide of mercury with Pruſſian blue. It forms cryſtals in four-ſided priſms, terminated by four-ſided pyramids. The ſpecific gravity is 2.7612. It forms triple ſalts with ſulphuric and muriatic acids, the properties of which are not known.

II. Action of Alkalies, &c.

There is no action between mercury and the alkalies or alkaline earths; but the alkalies combine with the oxides of mercury, and form with them compounds in which the latter ſeem to act the part of acids. Some of theſe compounds have been already treated of, in ſpeaking of the action of ammonia on ſome of the mercurial ſalts.

Salts formed with the alkalies and earths, have no action on mercury or its oxides, if we except the muriates. By diſſolving the muriate of mercury in a ſolution of muriate of ammonia, a triple ſalt, which is muriate of ammonia and mercury, and which has been already deſcribed, is obtained.

1750 Uſes. Mercury is one of the metals of the moſt extenſive utility. In the metallic ſtate it is applied to the conſtruction of meteorological inſtruments, as the barometer and thermometer. Mercury is alſo applied to a great variety of purpoſes in the arts; in gilding with ſilver and gold; in forming an amalgam with tin for covering the back of mirrors; and in metallurgy for the purpoſe of ſeparating gold and ſilver from their ores. Mercury is alſo of conſiderable importance for the purpoſes of chemiſtry. Many of its preparations form ſome of the moſt effectual and moſt certain remedies in different diſeaſes.

SECT. XV. *Of* ZINC *and its Combinations.*

1751 Hiſtory. 1. Paracelſus is the firſt who ſpeaks of zinc under its preſent name. It is ſuppoſed that the Greeks were acquainted with this metal in the ſtate of compound with copper, which formed the famous Corinthian braſs; but it does not appear that they made any diſtinction between it and other metals. It is particularly mentioned by Albertus Magnus, who died in 1280, and he ſeems to have known that it inflamed, and communicated a colour to metals with which it was combined. The method of obtaining zinc from the ore called *calamine*, is mentioned by Henckel in his Pyrotology in 1721. Swab extracted it by diſtillation in 1742, and Margraaf was occupied with this proceſs in 1746. Zinc was ſuppoſed by the earlier chemiſts to be a variety or compound of ſome of the other metals. Lemery thought it was a kind of biſmuth, and Homberg took it for a mixture of iron and tin; while others ſuppoſed that it was tin rendered brittle by ſulphur, or that it was a coagulated mercury.

1752 Ores. 2. Zinc is found in four different ſtates: In the ſtate of oxide, in the ſtate of ſulphuret, in that of ſulphate, and in that of carbonate. 1. In the ſtate of oxide it is known by the name of *calamine*, or *lapis calaminaris*, depoſited in a regular form, or in that of incruſtations and ſtalactites, in the cavities of metallic veins. 2. The ſulphuret of zinc, known by the name of *blende*, is ſometimes diſpoſed in ſcales, and ſometimes cryſtallized in tetrahedrons, or octahedrons. It is frequently found in lead mines, accompanying the ores of lead. 3. The ſulphate of zinc, which is found native, is readily known by its white colour and tranſparency, its ſtrong acrid taſte, and ſolubility in water. It is generally found in a ſtalactitical form, or in fine ſilky cryſtals, like thoſe of amianthus. 4. The native carbonate of zinc, which is ſometimes confounded with the oxide or calamine, forms another ore of zinc. It is tranſparent, white, or yellowiſh. It is inſipid and inſoluble in water, and diſſolves with effervescence in nitric and muriatic acids.

1753 Analyſis. 3. To reduce oxides of zinc to the metallic ſtate, the ore is pulverized and mixed with charcoal, and the mixture is heated in a crucible covered with a plate of copper. The zinc is ſublimed in the metallic ſtate, and combines with the copper, which it converts into braſs; and in this rude proceſs the richneſs of the ore is aſcertained by the intenſity of the colour. The ſulphurets of zinc are reduced by roaſting, by which proceſs the ſulphur is ſeparated, and the reſiduum is then treated in the ſame way as the oxides. In the humid way Bergman has propoſed to analyze the oxides of zinc by means of ſulphuric acid, and then by precipitating the oxide by carbonate of ſoda, he has aſcertained that 193 parts of this precipitate give 100 parts of the metal.

1754 Properties. 4. Zinc is of a brilliant white colour with a bluiſh ſhade, which is very perceptible in its metallic ſtate, and of a diſtinct lamellated texture; but the plates of which it is compoſed are ſmaller than thoſe of biſmuth and antimony. The ſpecific gravity is 7.190. Zinc is not quite ſo brittle as the preceding metals. It requires a ſmart and ſudden blow to ſeparate its fragments. It is ſuſceptible of a ſlight degree of malleability, for, by gradual and cautious preſſure, it may be formed into thin plates, which have ſome degree of elaſticity. It has a ſlight odour, and a peculiar taſte, which is communicated to the fingers when they are rubbed on this metal.

1755 Action of heat. 5. When zinc is expoſed to a heat of about 700° it melts, and by increaſing the heat it evaporates, ſo that in cloſe veſſels it may be diſtilled. When allowed to cool ſlowly after being in fuſion, it cryſtallizes in fine needles. When zinc is expoſed to the air, it undergoes very little alteration in the cold. Its brilliancy is ſlightly tarniſhed, and it becomes at length covered with a thin gray oxide.

1756 Oxidation. When zinc is fuſed in cloſe veſſels and expoſed to heated air, at the moment it becomes ſolid on the ſurface, it exhibits a great variety of ſhades of colour, which is the commencement of oxidation. When it is kept in fuſion, in the open air, the ſurface becomes covered with a gray pellicle, which being removed, is ſucceeded by another, till the whole of the zinc is converted into this gray-coloured matter, which is an oxide of zinc. This proceſs may be promoted by agitating the veſſel, ſo that the metal in fuſion may be expoſed to the air. By heating together the gray pellicles which have been collected in an open veſſel, the whole is converted into a uniform gray powder, which at laſt aſſumes a yellowiſh colour. The yellow oxide, thus formed, has acquired an additional weight of about 17 per cent of the metallic zinc.

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* Klaproth Eſſays, ii. 102. Tranſl.

When this metal is heated to redneſs in an open veſſel, by agitating the veſſel, it ſuddenly takes fire, and burns with a very brilliant white, and ſomewhat greeniſh flame. Zinc is at the ſame time reduced to a ſtate of vapour, which is condenſed in the air, in light, filamentous, white flakes, of a very delicate texture. This is an oxide of zinc. It has been diſtinguiſhed by different names, as *flowers of zinc*, *nihil album* or *white nothing*, *lana philoſophica*, or *philoſophic wool*.

1757 Oxides two. Thus, there are two oxides of zinc; the gray oxide, which conſiſts of about 88 parts of zinc, and 12 of oxygen, and the white oxide, which, according to Prouſt, is compoſed of 80 parts of zinc, and 20 of oxygen.

1758 Action of hydrogen. There is no action between azote and this metal. Hydrogen gas, it is ſuppoſed, diſſolves a ſmall quantity of zinc; for by diſſolving zinc in diluted ſulphuric acid, the hydrogen gas which is obtained by the decompoſition of the water, has been found to hold a little zinc in ſolution, which is depoſited on the ſides of the jars containing the gas. 1759 Of carbone. It is ſuppoſed too, that zinc is ſometimes combined with carbone, becauſe hydrogen gas obtained by the above proceſs, is ſometimes contaminated with carbonated hydrogen gas.

1760 Phoſphuret. 7. Zinc combines with phoſphorus, and forms a phoſphuret. This may be prepared by adding ſmall bits of phoſphorus to zinc in fuſion, but previouſly throwing in a little reſinous matter, to prevent the oxidation of the zinc. This was the proceſs by which Pelletier formed the phoſphuret of zinc. This phoſphuret is of a white colour and metallic luſtre. It has ſome degree of malleability. When it is hammered, it emits the odour of phoſphorus, and when expoſed to a ſtrong heat, it burns like zinc. 1761 Phoſphorated oxide. Phoſphorus alſo enters into combination with the oxide of zinc, and forms with it a phoſphorated oxide. This is formed by diſtilling in an earthen-ware retort, equal parts of oxide of zinc, and phoſphoric glaſs, with one-ſixth of charcoal powder. A ſtrong heat is applied, and a metallic ſubſtance of a ſilvery white colour is ſublimed, which has a vitreous fracture. When it is heated by the blow-pipe, the phoſphorus burns, and there remains behind a vitreous matter, which is tranſparent while in fuſion, but becomes opaque when it is cold.

1762 Sulphuret. 8. Zinc has not been combined directly with ſulphur. When they are heated together in a crucible, the ſulphur ſeparates without producing any other change on the zinc than that of being a little more infuſible; but it has been obſerved that ſulphur and zinc, when fuſed together in a crucible, enter into combination, as the zinc is oxidated. This compound aſſumes a browniſh gray colour. Guyton afterwards diſcovered that ſulphur and the oxide of zinc readily unite together by fuſion, and that the compound is of a gray colour, ſimilar to the native ſulphuret of zinc, as it has been called, or the ſulphurated oxide of zinc, according to this experiment; but according to Prouſt, the ore of zinc, which is known by the name of *blende*, is a ſulphuret, that is, ſulphur combined with zinc in the metallic ſtate.

1763 Affinities. 9. The order of the affinities of zinc and its oxide is the following:

Zinc.	Oxide of Zinc.
Copper,	Oxalic acid,
Antimony,	Sulphuric,
Tin,	Muriatic,
Mercury,	Saclactic,
Silver,	Nitric,
Gold,	Tartaric,
Cobalt,	Phoſphoric,
Arſenic,	Citric,
Platina,	Succinic,
Biſmuth,	Fluoric,
Lead,	Arſenic,
Nickel,	Lactic,
Iron.	Acetic,
	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Zinc.

1. Sulphate of Zinc.

1764 Preparation. 1. Sulphuric acid diluted with water, acts very powerfully on zinc. A violent effervescence takes place; the mixture is ſtrongly heated, and a great quantity of hydrogen gas is evolved. In this proceſs, which is uſually followed for obtaining the pureſt hydrogen gas for chemical purpoſes, the water is decompoſed; its oxygen combines with the metal and forms an oxide, which is then diſſolved in the ſulphuric acid, and forms a ſulphate of zinc, while the hydrogen, the other component part of the water, eſcapes in the form of gas. A black powder is ſometimes obſerved floating in the ſolution, which is carburet of iron, with which the zinc is frequently contaminated. As the effervescence ceaſes, a white powder is formed, which gradually diſappears towards the end of the proceſs, and with the addition of water forms a tranſparent ſolution. By evaporation and cooling, the ſulphate of zinc is obtained cryſtallized.

1765 Properties. 2. The ſulphate of zinc is frequently contaminated with other metals, as with lead, iron and copper; but when it is pure, it cryſtallizes in four-ſided priſms, terminated by pyramids with four faces. This ſalt has an acrid, aſtringent, and ſtrongly metallic taſte. When it is expoſed to the air it effloreſces. It is ſoluble in leſs than two and a half parts of cold water, and more ſoluble in boiling water. The ſpecific gravity of the cryſtallized ſalt is 1.912; but as it is generally met with in the ſhops, it is only 1.3275. When heated in a retort, it melts, loſes its water of cryſtallization, and part of its acid in the ſtate of ſulphurous acid, and a little water. It is decompoſed and precipitated in the ſtate of white oxide by all the alkalies; and if the precipitate is formed by means of the carbonates, a white pigment is obtained. The ſulphate of zinc is alſo decompoſed with the aſſiſtance of heat, by means of nitre. The alkaline ſulphurets and hydroſulphurets alſo precipitate the ſulphate of zinc, 1766 Compoſition. zinc, of a deep orange or brown colour. The component parts of this ſalt are, according to

	Bergman.	Kirwan.
Acid	40	20.5
Oxide	20	40.0
Water	40	39.5
	100	100.0

1767 White vitriol. 3. The ſalt, known in commerce by the name of *white vitriol*, is a ſulphate of zinc, and is ſuppoſed to contain an exceſs of acid. It is in the form of white granular maſſes, reſembling ſugar, and often marked with yellow ſpots. This ſalt is uſually prepared by roaſting the ſulphuret of zinc or blende, by which means the ſulphuret is converted into ſulphuric acid. It is then diſſolved in water, which is purified and evaporated, and the ſalt is cryſtallized by ſudden cooling. Part of its water of cryſtallization is afterwards driven off by heat, ſo that it is obtained in a regular, ſolid, and granulated maſs. It is generally contaminated with iron and other metals; but it may be purified from theſe, by adding filings of zinc, which precipitate the other metals, and leave a pure ſulphate of zinc.

2. Sulphite of Zinc.

1768 Preparation. Concentrated ſulphurous acid readily combines with the white oxide of zinc, without any effervеſcence, but with the evolution of heat, and the acid being deprived of its odour. When the ſaturation is completed, white cryſtals appear on the ſurface of the liquid. This ſalt has a pungent, aſtringent taſte. It cryſtallizes readily. It is decompoſed by the acids, with effervеſcence. 1769 Properties. It is inſoluble in alcohol. It forms white precipitates with the alkalies, and when expoſed to the air, it is readily converted into ſulphate of zinc.

1770 Combines with ſulphur. *Sulphurated ſulphite of Zinc.*—When ſulphurous acid is added to zinc in the ſtate of powder or filings, a great degree of heat is produced; ſulphurated hydrogen gas is diſengaged; the liquid becomes at firſt brown, ſometimes muddy, and aſſumes a yellow colour, and towards the end of the proceſs it becomes tranſparent. The ſolution has an acrid, aſtringent, and ſulphureous taſte. Sulphuric and muriatic acids diſengage with effervеſcence, ſulphurous acid gas, and precipitate a yellowiſh-white powder. Nitric acid at firſt ſeparates ſulphurous acid gas, and afterwards a flaky precipitate, which is pure ſulphur. When this ſolution is expoſed to the air, it becomes thick like honey, and affords cryſtals in the form of needles or fine four-ſided priſms, terminated by four-ſided pyramids. Theſe are cryſtals of ſulphurated ſulphite of zinc, 1771 Properties. which become white by expoſure to the air, and form a white powder inſoluble in water. When this ſalt is heated by the blow-pipe, it ſwells up, gives out a bright light like burning zinc, and forms dendritical ramifications. This ſalt is partly ſoluble in alcohol. The part not diſſolved, only gives out ſulphurous acid gas by means of ſulphuric acid, whilſt the part which is diſſolved affords, beſides ſulphurous acid gas, a copious precipitate of ſulphur. When it is diſtilled in a retort, it gives out water, ſulphurous acid, ſulphuric acid, and ſulphur ſublimed. There remains behind oxide of zinc, mixed with a little of the ſulphate.

1772 Theory of the proceſs. In the ſolution of zinc in liquid ſulphurous acid, water, and part of the ſulphurous acid itſelf, are decompoſed; for ſulphurated hydrogen gas is diſengaged, which is compoſed of the hydrogen of the water and part of the ſulphur of the ſulphurous acid. There is no precipitation of ſulphur during the ſolution, for it combines with the ſulphite of zinc, as it is formed; but this is not completely ſaturated, ſince alcohol diſſolves only the portion of ſulphurated ſulphite which it contains, and ſeparates the ſulphite *.

3. Nitrate of Zinc.

1773 Preparation. 1. Concentrated nitric acid produces a violent action with zinc, and ſometimes even inflames it. To effect this ſolution, with a moderate action, the acid ſhould be diluted with water. Great heat is produced, with violent effervеſcence and the evolution of nitrous gas. The acid is decompoſed; its oxygen combining with the metal, forms an oxide, which combines with the acid as it is formed.

1774 Properties. 2. This ſolution is of a greeniſh-yellow colour, and extremely cauſtic. By evaporation it affords cryſtals, in the form of four-ſided, compreſſed, and ſtriated priſms, terminated by four-ſided pyramids. The ſpecific gravity is 2.096. This ſalt is deliqueſcent in the air. When it is heated on burning coals, it melts, and detonates with a ſmall red flame. When heated in a crucible, it gives out red vapour, and aſſumes a deep colour and gelatinous conſiſtence. When cooled in this ſtate, it retains its ſoftneſs for ſome time. By continuing the heat, it dries, gives out nitrous and oxygen gaſſes, and leaves behind a yellow oxide.

4. Muriate of Zinc.

1775 Preparation. Muriatic acid produces a rapid action on zinc. It is diſſolved with effervеſcence, and with the evolution of pure hydrogen gas. The ſolution of zinc in muriatic acid is colourleſs; it does not cryſtallize, but aſſumes the form of a tranſparent jelly. It affords by diſtillation a ſmall quantity of fuming acid, and a ſolid muriate of zinc, which is fuſible with a moderate heat, and was formerly known by the name of *butter of zinc*. When this muriate of zinc is ſublimed by heat, it becomes of a fine white colour, compoſing a maſs of cryſtals in the form of ſmall priſms. It is decompoſed by ſulphuric acid, and is precipitated by the alkalies. 1776 Properties. It is ſoluble in water, attracts moiſture from the atmoſphere, and is ſoon converted into a tranſparent jelly. The ſpecific gravity is 1.577.

5. Muriate of Ammonia and Zinc.

This triple ſalt is formed by boiling white oxide of zinc in a ſolution of muriate of ammonia. The oxide of zinc is diſſolved; part of which is afterwards depoſited, when the ſolution cools, but what remains in the ſolution is not precipitated by the alkalies or the alkaline carbonates.

6. Fluate of Zinc.

Fluoric acid produces a violent action with zinc; there is conſiderable effervеſcence, with the evolution of hydrogen gas. The metal is oxidated, and then diſſolves in the acid; but the properties of this ſalt are little known.

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* *Fourcroy* v. p. 380.

7. Borate of Zinc.

Boracic acid combines with the oxide of zinc, by adding the borate of potaſh or ſoda to the ſolution of zinc in nitric or muriatic acid. This ſalt is inſoluble in water.

8. Phoſphate of Zinc.

1777 Preparation. Phoſphoric acid diluted with water, acts upon zinc with the evolution of hydrogen gas, owing to the decompoſition of water. A white powder is depoſited, which is phoſphate of zinc. By expoſing phoſphoric glaſs and zinc to a ſtrong heat, a phoſphuret of zinc is formed, by the decompoſition of the acid.

9. Carbonate of Zinc.

1778 Preparation. Zinc reduced to a fine powder, and added to liquid carbonic acid, is oxidated and copiouſly diſſolved in the acid, at the end of 24 hours. This ſolution, expoſed to the air, is covered with a pellicle of carbonate of zinc of different colours. The carbonate of zinc is found native, and has been diſtinguiſhed by the name of *calamine*, thus confounding it with the oxide of zinc. Carbonate of zinc, according to the analyſis of Bergman, is compoſed of

Acid	28
Oxide	66
Water	6
	100

10. Arſeniate of Zinc.

When arſenic acid is added to zinc, it produces an effervescence, with the evolution of hydrogen gas, holding arſenic in ſolution. A black powder is depoſited, which is metallic arſenic. In this proceſs, the zinc decompoſes part of the water, and combines with its oxygen, and at the ſame time deprives the arſenic acid of its oxygen, by which it is reduced to the metallic ſtate. The arſeniate of zinc may be obtained by adding a ſolution of an alkaline arſeniate to a ſolution of the ſulphate of zinc. A white precipitate is formed, which is the arſeniate of zinc. It is inſoluble in water.

11. Tungſtate of Zinc.

12. Molybdate of Zinc.

Theſe ſalts may be formed by a ſimilar proceſs. A white powder is obtained, which is inſoluble in water.

13. Chromate of Zinc.

This ſalt is obtained by combining an alkaline chromate with a ſolution of zinc in nitric acid. A precipitate is formed of an orange red colour, which is chromate of zinc.

14. Columbate of Zinc.

Unknown.

15. Acetate of Zinc.

1779 Preparation and properties. Acetic acid diſſolves zinc, and the ſolution by evaporation cryſtallizes in the form of rhomboidal or hexagonal plates. This ſalt has a bitter metallic taſte, is not altered by expoſure to the air, and is ſoluble in water. It burns with a blue flame when thrown on burning coals. When diſtilled, it yields water, an inflammable liquid, and ſome oil. At the end of the proceſs, when the ſalt is completely decompoſed, the oxide of zinc is ſublimed, which being brought in contact with a candle, burns with a fine blue flame. The reſiduum is in the ſtate of pyrophorus, but it has little combuſtibility.

16. Oxalate of Zinc.

Oxalic acid acts upon zinc with effervescence, and the evolution of hydrogen gas. Water is decompoſed, and as the zinc is oxidated, it combines with the acid, forming an oxalate of zinc. It is in the ſtate of white powder, of an acrid taſte, and but little ſoluble in water.

17. Tartrate of Zinc.

Tartaric acid combines with zinc with effervescence, and the evolution of hydrogen gas. The properties of this ſalt have not been examined.

18. Citrate of Zinc.

Citric acid acts upon zinc with effervescence and the evolution of hydrogen gas. At the end of 24 hours the action ceaſes, and the liquid depoſits on the ſides of the veſſel and on its ſurface, ſmall, brilliant cryſtals in the form of plates, which are inſoluble in water. The citrate of zinc has an aſtringent, metallic taſte. It is compoſed of equal parts of acid and of oxide of zinc.

19. Malate of Zinc.

Malic acid diſſolves zinc, and by evaporating the ſolution, cryſtals may be obtained.

20. Benzoate of Zinc.

Benzoic acid readily diſſolves zinc, and by evaporation the ſolution affords needle-ſhaped cryſtals. The benzoate of zinc is ſoluble in water and alcohol. When it is expoſed to heat, the acid is ſublimed.

21. Succinate of Zinc.

Zinc is diſſolved in ſuccinic acid with effervescence. By evaporation the ſolution affords ſlender, foliated cryſtals.

22. Lactate of Zinc.

Zinc is ſoluble in lactic acid with effervescence, and by evaporating the ſolution, the ſalt may be obtained cryſtallized.

II. Action of Alkalies, &c. on Zinc.

1780 Fixed alkalies. 1. When zinc is immerſed in a ſolution of potaſh or ſoda, it is tarniſhed, and becomes black, and when it is boiled in the ſolution, hydrogen gas is evolved. The ſolution aſſumes a dirty-yellow colour, from which an oxide of zinc may be precipitated by acids.

2. Ammonia

1781 Ammonia. 2. Ammonia has a ſtill more powerful action on zinc. Hydrogen gas is more copiouſly evolved, and the oxide which is formed is more abundantly diſſolved in the liquid, and at the end of ſome time a conſiderable quantity of white oxide is depoſited. Theſe alkaline ſolutions become turbid by expoſure to the air; its oxygen and carbonic acid, acting at the ſame time, precipitate the oxide.

1782 Sulphates. 3. The alkaline and earthy ſulphates are readily decompoſed by zinc, with the aſſiſtance of heat. It attracts the oxygen of the ſulphuric acid, and thus decompoſing it, ſeparates the ſulphur, which combines with the baſes of the ſulphates. Alum boiled in ſolution with zinc, is decompoſed, and there is formed a triple ſalt, which is ſulphate of zinc and alumina.

1783 Nitrates. 4. The nitrates produce a vivid inflammation with zinc at a red heat. The acid is decompoſed, its oxygen combines with the metal, and by this rapid combination, a violent detonation is produced. The azotic gas is diſengaged, and the zinc is fully oxidated. Three parts of nitre well dried, and one of zinc in fine powder, well mixed together and projected into a red-hot crucible, produce a very brilliant inflammation. The burning matter is ſometimes thrown out to a conſiderable diſtance; ſo that the experiment ſhould be made with caution. This compound is ſometimes employed in fire-works.

1784 Muriates. 5. Zinc has a conſiderable action on the muriates. Triturated with the muriate of ammonia, the ſalt is decompoſed, and ammonia is diſengaged. By diſtilling this ſalt with zinc, ammoniacal and hydrogen gaſes are obtained; the latter is obviouſly owing to the decompoſition of the water contained in the ſalt, by means of the zinc, which combines with the oxygen, and then forms a muriate of zinc with the muriatic acid.

1785 Phoſphates, &c. 6. The phoſphates and borates combine by fuſion with the oxide of zinc, which communicates to the glaſs thus formed a greeniſh-yellow colour.

7. Zinc decompoſes the greateſt number of the metallic ſalts from their ſolutions, by its ſtrong affinity for oxygen. They are precipitated in the metallic form, or in the ſtate of oxide, but deprived of a portion of oxygen.

1756 Uſes. 8. Zinc is employed in many of the arts. It forms uſeful alloys with ſome of the other metals, ſome of which will be mentioned afterwards. It is alſo employed in medicine. The ſulphate of zinc is ſometimes exhibited as an emetic, and frequently uſed in ſolution as an eye-waſh. The oxide of zinc, or the flowers of zinc, have been preſcribed as an antiſpaſmodic, and particularly in caſes of epilepſy.

Sect. XVI. *Of Tin and its Combinations.*

1787 Hiſtory. 1. Tin has been known from the earlieſt ages. It was much employed by the Egyptians in the arts, and by the Greeks as an alloy with other metals. Pliny ſpeaks of it under the name of white lead, as a metal well known in the arts, and even applied in the fabrication of many ornaments of luxury. He aſcribes to the Gauls the invention of the art of tinning, or covering other metals with a thin coat of tin. The alchemiſts were much employed in their reſearches concerning tin. They gave it the name of *Jupiter*, from which the ſalts or preparations of tin were called *jovial*. Since their time, the nature and properties of tin have been particularly inveſtigated by many chemiſts, and it has proved the ſubject of ſome important diſcoveries in chemical ſcience. So early as the year 1630, John Rey threw out a conjecture, that the air was fixed in this metal during its calcination. Boyle, towards the end of the ſame century, attempted to account for the increaſe of weight which this metal acquired during this proceſs; but this was only fully aſcertained by Lavoiſier, who repeated the experiment of Boyle, and calcined the metal in cloſe veſſels; but the method of conducting this experiment and the reſult of it, have been already detailed.

1788 Ores. 2. Tin exiſts in nature in three different ſtates. It is found native, in the ſtate of oxide, and in that of ſulphurated oxide. Native tin is in brilliant plates, or regularly cryſtallized. The native oxide of tin, which is the moſt common ore of this metal, exiſts under a variety of forms. It is generally found cryſtallized. The ſulphuret of tin is of a pale or dark gray colour, and when pure, has ſome reſemblance to an ore of ſilver.

1789 Analyſis. 3. To obtain the metal from its ores, they are firſt roaſted, and then treated with a flux, to reduce the metal. It has been recommended by ſome, to mix a ſmall quantity of pitch with the fuſed maſs, to prevent the oxidation of the tin. After the ore is roaſted, it fuſes readily with three times its weight of black flux, and a little decrepitated muriate of ſoda.

In the humid way, native tin may be diſſolved in nitric acid, which readily oxidates, and reduces it to the ſtate of white powder, which is an oxide of tin; and if it contain iron and copper, theſe two metals remain in the ſolution.

1790 Properties. 4. Tin is of a white colour, nearly as brilliant as ſilver. The ſpecific gravity of tin is 7.291. It is one of the ſofteſt of the metals. It may be ſcratched with the nail, and eaſily cut with a knife. It is extremely flexible, and produces a peculiar noiſe when it is bent or folded. It is ſo malleable, that it can be eaſily beaten out to $\frac{1}{1000}$ part of an inch, which is the thickneſs of tinfoil. It has little elaſticity or tenacity. A wire of this metal about $\frac{1}{10}$ of an inch in diameter ſupports a weight of about 30lbs. without breaking.

1791 Action of heat. 5. Tin is ſuſceptible of very conſiderable expanſion by means of caloric, and on this account it has been propoſed to employ it as a pyrometer. Tin is one of the moſt fuſible of the metals, and melts at the temperature of 442°, but it requires a very high temperature to raiſe it in vapour. If it be allowed to cool ſlowly, and when the ſurface becomes ſolid, by pouring out part of the liquid metal, cryſtals are formed, in large rhomboids, compoſed of a great number of ſmall needles.

1792 Odour, &c. 6. Tin is a good conductor of electricity. It poſſeſſes a peculiar odour, which is communicated to the hands by friction. It has alſo a perceptible taſte.

1793 Oxidation. 7. When this metal is expoſed to the air, it is ſoon tarniſhed, and aſſumes a grayiſh white colour; but it undergoes no farther change. When it is melted in an open veſſel, it is ſoon covered with a grayiſh pellicle, which is the commencement of the oxidation of the metal. When this pellicle is removed, another forms, and ſo on ſucceſſively till the whole is oxidated. By continuing the heat, and by agitation, the proceſs goes on more rapidly, and the metal is converted into a whitiſh powder. This oxide contains about 20 parts of oxygen in 100 of the metal. With the addition of lead to promote the oxidation, this oxide is the *putty of tin*. It contains about two parts of oxide of lead, and one part of oxide of tin. But when tin is ſtrongly heated, it is converted into a fine white oxide, which during the proceſs gives out a vivid white flame. This oxide is condenſed in the cold, and cryſtallizes in ſhining tranſparent needles.

1794 Two oxides. According to Prouſt, tin combines with two proportions of oxygen, thus forming two oxides. The yellow oxide, which has the ſmaller proportion of oxygen, may be prepared by diſſolving tin in nitric acid diluted with water, without the aid of heat. By precipitating the oxide with pure potaſh, it is obtained in the form of a yellowiſh powder. Its component parts are thoſe already ſtated, namely,

20 oxygen,
80 tin,

100

By diſſolving tin in concentrated nitric acid, with the aſſiſtance of heat, the whole is converted with effervеſcence into a white powder, which falls to the bottom of the veſſel. The component parts of this oxide are, 28 oxygen, and 72 of tin.

8. There is no action between tin and azote, hydrogen, or carbone, nor is there any perceptible action between tin or its oxides and water.

1795 Phoſphuret. 9. Phoſphorus combines very readily with tin, by projecting bits of phoſphorus on melted tin in a crucible. A phoſphuret of tin is thus obtained, which cryſtallizes on cooling. This compound is of a ſilvery white colour, may be cut with a knife, and extended under the hammer, but ſoon ſeparates into plates. The filings of this phoſphuret are like thoſe of lead, and when they are thrown on red-hot coals, they take fire, and burn with the ſmell and flame of phoſphorus. By the action of the blow-pipe, the phoſphorus only burns, and the ſmall metallic button which remains is ſurrounded with a tranſparent glaſs. Pelletier diſtilled this phoſphuret often with hyperoxymuriate of mercury, and obtained a fuming muriate of tin, with the mercury reduced to the metallic ſtate, and phoſphorated hydrogen gas, which exploded as it came in contact with the air. There remained in the retort a ſpongy inflammable matter, which he ſuppoſed to be a compound of tin and phoſphorus.

1796 Sulphuret. 10. Sulphur combines very readily with tin, by adding the ſulphur to the metal while in a ſtate of fuſion. This compound forms a grayiſh or bluiſh matter, which has a metallic luſtre, a lamellated ſtructure,
1797 Compoſition. and cryſtallizes in cubes, or in octahedrons. It is decompoſed by acids with effervеſcence. The component parts are, according to

	Bergman.	Pelletier.
Tin,	80	85
Sulphur,	20	15
	100	100

1798 Sulphurated oxide. 11. If equal parts of oxide of tin and ſulphur be fuſed together in a retort, ſulphurous acid and ſome ſulphur are diſengaged, and there remains in the veſſel a compound of a brilliant golden colour. It cryſtallizes in ſix-ſided plates. It is not acted on by the acids. When it is ſtrongly heated, it gives out ſulphurous acid and ſulphur, and there remains behind a black maſs which is ſulphuret of tin. This compound, which is a ſulphurated oxide of tin, was formerly diſtinguiſhed by the name of *aurum muſivum*, *muſicum*, or *moſaicum*. The component parts of this ſulphurated oxide of tin are,

Oxide of tin,	60
Sulphur,	40
	100

1799 Affinities. 12. Tin enters into combination with many of the metals, and forms alloys with them, ſome of which are of great importance. It alſo combines with acids, and forms ſalts. The affinities of tin and its oxides are in the following order.

TIN.	OXIDE of TIN.
Zinc,	Tartaric acid,
Mercury,	Muriatic,
Copper,	Sulphuric,
Antimony,	Oxalic,
Gold,	Arſenic,
Silver,	Phoſphoric,
Lead,	Nitric,
Iron,	Succinic,
Manganeſe,	Fluoric,
Nickel,	Saclactic,
Arſenic,	Citric,
Platina,	Lactic,
Biſmuth,	Acetic,
Cobalt,	Boracic,
Sulphur.	Pruſſic.

I. Salts of Tin.

1. Sulphate of Tin.

1800 Two ſulphates. 1. Sulphuric acid acts very feebly on tin in the cold. The acid, however, is at laſt decompoſed; its oxygen combines with the metal, ſulphurous acid gas is emitted, and the oxide falls to the bottom in the ſtate of white powder. In this caſe, the oxide has the ſmaller proportion of oxygen, and then the ſolution is more permanent. There is no precipitation by water.

2. But when the ſolution of tin in ſulphuric acid is promoted by the action of heat, the acid is ſtill farther decompoſed; a greater quantity of ſulphurous acid is given out, and ſulphur is depoſited. In this caſe the white oxide of tin is formed. This compound, when evaporated, aſſumes the form of a jelly, and does not cryſtallize by the addition of water. It is precipitated in the form of white powder. The firſt might be called the yellow ſulphate of tin, and the ſecond the white ſulphate of tin.

2. Sulphite of Tin.

When tin is immerſed in liquid ſulphurous acid, it aſſumes a yellow colour. At the end of ſome days it becomes black like charcoal, and there is depoſited in the liquid a black powder. In this proceſs part of the ſulphurous acid is decompoſed; its oxygen combining with the metal, forms an oxide, which enters into combination with another part of the acid, and forms the ſulphite of tin. A portion of ſulphur is depoſited along with a white ſulphite, which is not very ſoluble, and another portion remains in ſolution with part of the ſulphite, forming a ſulphurated ſulphite. A third portion of the ſulphur combines with part of the metallic tin, and forms a black ſulphuret, on which the acid has no action *.

3. Nitrate of Tin.

1801 History. 1. Nitric acid produces a very violent action with tin. It is accompanied with great heat, and the evolution of nitrous gas. The metal is converted into a white oxide, which gives to the liquid the appearance of coagulated milk. It had been long obſerved by chemiſts, that the ſolution of tin in nitric acid was not permanent, for by evaporating or concentrating the ſolution, the oxide is always precipitated. This difficulty has been ſolved by the diſcoveries of modern chemiſtry.

1802 Preparation. 2. If tin be diſſolved in nitric acid, diluted with water, and the great increaſe of temperature moderated by the application of cold, as by immerſing the veſſel in cold water, a ſolution of a ſmall quantity of the oxide of tin is effected. The ſolution is of a yellow colour, and contains the oxide of tin, with a ſmaller proportion of oxygen, which is the yellow oxide. In this proceſs the tin is chiefly oxidated by the decompoſition of the water. In this proceſs too, ammonia is formed from the azote of the acid combining with the hydrogen of the water. This becomes perceptible by adding potaſh to the liquid. When the ſolution is heated, the oxide of tin is ſeparated in great abundance.

1803 In different proportions. 3. But when nitric acid is more concentrated, a more violent action takes place between this acid and tin. The metal is oxidated, and the whole of it ſeparates from the liquid. To one part of pure nitric acid Guyton added $1\frac{1}{2}$ of tin in a retort, when a violent efferveſcence took place, but no gas was given out. In this experiment a quantity of ammonia equal to $\frac{1}{20}$ of the weight of the acid and tin employed, was formed. The acid and the water are decompoſed, and the oxygen of both combines with the tin, and forms an oxide, while the azote of the acid and the hydrogen of the water combine together and form ammonia. In this ſtate of oxidation, the tin does not combine with the acid.

4. Muriate of Tin.

1804 Preparation. 1. Concentrated muriatic acid diſſolves tin, either in the cold or with the aſſiſtance of a gentle heat. The acid is ſoon deprived of its fuming property, and of its yellow colour. A ſlight effervеſcence takes place, which is owing to the decompoſition of water, and the evolution of a fetid hydrogen gas. This peculiar odour is ſuppoſed to be occaſioned by the hydrogen gas holding in ſolution a portion of the metal. Muriatic acid diſſolves more than $\frac{1}{2}$ its weight of tin. No precipitate is formed, as with the other acids.

1805 Properties. When it is evaporated, it furniſhes cryſtals in the form of brilliant needle-ſhaped priſms, which are deliqueſcent in the air.

1806 Decompoſition. 2. This muriate of tin is precipitated by the alkalies in the form of a copious white oxide, which is re-diſſolved with an exceſs of alkali. The alkaline ſolution is of a browniſh yellow colour. The ſulphuret of ammonia precipitates this ſalt in the form of powder, which becomes black as it dries, and by diſtillation yields ammonia and *aurum muſivum*. The ſulphuret of potaſh produces a yellow precipitate, which, by diſtillation furniſhes ſulphurous acid and ſulphur, and what remains is converted into *aurum muſivum*, or the ſulphurated oxide of tin. This oxide precipitated by means of ſoda, and diſtilled with its weight of ſulphur, yields ſulphurous acid gas, ſulphur, and the reſiduum is *aurum muſivum*.

1807 Abſorbs oxygen. 3. This ſolution of tin abſorbs oxygen, with the evolution of heat, from oxymuriatic acid, which is deprived of its odour. With nitric acid, a violent effervеſcence takes place. Nitrous gas is diſengaged, and in both theſe caſes, the oxide of tin combines with an additional portion of oxygen. With the addition of ſulphurous acid, this ſolution of tin depoſits the yellow ſulphurated oxide of a fine bright colour. 1808 Forms an oxymuriate. This ſolution converts arſenic acid into the metallic ſtate, and it produces the ſame effect on the molybdic and tungſtic acids, by combining with their oxygen. The red oxide of mercury, the hyperoxymuriate of mercury, the white oxide of antimony, the oxides of zinc and ſilver, are all reduced to the metallic ſtate by being deprived of their oxygen by the muriate of tin. This muriate alſo precipitates from the ſolution of gold, *the purple powder of Caſſius*, by attracting that portion of oxygen which renders the oxide of gold ſoluble. In all theſe proceſſes, the reſults of which were aſcertained by Pelletier, the muriate of tin is converted into an oxymuriate.

1809 Formed by another proceſs. 4. This oxymuriate of tin is formed by making a ſtream of oxymuriatic acid gas paſs into a ſolution of muriate of tin. It is alſo prepared by triturating equal parts of an amalgam, conſiſting of two parts of tin, and one of mercury, and muriate of mercury, or corroſive ſublimate, and diſtilling this mixture in a glaſs retort, with a very moderate heat. A colourleſs liquor firſt paſſes over, which is followed with the ſudden evolution of a white vapour, which lines the inſide of the receiver. This vapour is condenſed into a tranſparent liquid, which, in the air, exhales a copious, heavy, white vapour, from which this liquid has been called *the ſmoking liquor of Libavius*, or the *oxymuriate of tin*. When this liquor is included in a veſſel, it no longer gives out any viſible vapour, but it depoſits at the top of the veſſel needle-ſhaped cryſtals, while ſimilar cryſtals are precipitated to the bottom. Water does not precipitate the fuming muriate of tin. When it is thrown into the water, it produces a noiſe ſimilar to that which is occaſioned by concentrated ſulphuric acid. A number of tranſparent bubbles of air being evolved from the mixture, collect on the ſurface, and become white by the contact of air. By agitating the water, they are more readily diſſipated, and the liquid fumes no longer.

1810 In nitromuriatic. 5. Nitromuriatic acid, which is compoſed of one part of nitric acid, and two or three of muriatic acid, very readily diſſolves tin. A ſtrong heat is produced,

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* Fourcroy Connaiſs. Chim. vi. p. 30.

which may be moderated by immerſing the veſſel, in which the ſolution is made, in cold water. The metal ſhould be added in ſmall portions, and one part ſhould be diſſolved before the addition of another. In this way the acid will diſſolve half its weight of tin. It is by this proceſs that the muriate of tin is obtained for the purpoſe of dyeing ſcarlet; but it is found to vary conſiderably in its effects, which, no doubt, depends on the ſtrength of the acids employed, and the different proportions in the mixture. This ſolution is almoſt always coloured. Sometimes it affords a gelatinous maſs on cooling, which becomes in time more ſolid. Sometimes it is of a white colour like milk. This ſolution has not the fetid odour of the ſimple ſolution of tin in muriatic acid. It often happens, that it does not aſſume the viſcid or ſolid form, without the addition of $\frac{1}{3}$ its weight of water. It is then ſlightly opaque, which is owing to the precipitation of part of its oxide. When this ſolution is heated, an efferveſcence takes place; the tin is more ſtrongly oxidated, and it is generally after this proceſs that it aſſumes the form of a tranſparent jelly.

5. Fluate of Tin.

Fluoric acid has very little action on tin, but it diſſolves its oxide, and forms with it a ſolution which aſſumes a gelatinous form. The fluate of tin may be alſo obtained by adding a ſolution of an alkaline fluate to a ſolution of tin in muriatic acid.

6. Borate of Tin.

By a ſimilar proceſs boracic acid combines with the oxide of tin, and forms a borate of tin, which is inſoluble.

7. Phoſphate of Tin.

This ſalt may be formed by precipitating the oxide of tin from its ſolution in muriatic acid, by means of an alkaline phoſphate. A phoſphate of tin is thus obtained, which is inſoluble in water.

8. Carbonate of Tin.

This ſalt is prepared by precipitating the oxide of tin from its ſolution in muriatic acid, by means of the carbonates of the alkalies. When this carbonate of tin is diſſolved in an acid, it effervefces; but, according to Bergman, the oxide of tin, precipitated by an alkaline carbonate, is not found to have received any ſenſible addition of weight, ſo that the efferveſcence occaſioned by the action of an acid, on what is ſuppoſed to be a carbonate of tin, probably depends on the decompoſition of the acid itſelf.

9. Arſeniate of Tin.

Arſenic acid, with a moderate heat, diſſolves a ſmall quantity of tin, and the ſolution aſſumes the form of a jelly. Arſeniate of tin is formed, by adding to a ſolution of tin in muriatic acid, an alkaline arſeniate. A precipitate is formed, which is arſeniate of tin in the ſtate of inſoluble powder.

All the metallic acids are decompoſed by means of tin. They alſo combine with the oxide of tin, and form ſalts in the ſtate of powder, which has little ſolubility.

10. Acetate of Tin.

Acetic acid diſſolves only a ſmall portion of tin; but when the acid is boiled on tin, the action is more powerful, and the ſolution, which is of a whitiſh colour, affords by evaporation ſmall cryſtals. The ſolution of tin in acetic acid ſometimes does not cryſtallize, but affords only a gelatinous maſs; ſo that, by the action of acetic acid on tin, the metal is either in different degrees of oxidation, or there are different proportions of the acid and baſe.

11. Oxalate of Tin.

Oxalic acid added to tin in thin plates or filings, firſt blackens the ſurface, which is afterwards covered with a white powder. The oxalate of tin, which is ſoluble in water, has an auſtere metallic taſte. By ſlow evaporation it furniſhes needle-ſhaped or priſmatic cryſtals. When it is more rapidly evaporated, it affords a tranſparent maſs like horn.

12. Tartrate of Tin.

Tartaric acid diſſolves the oxide of tin, but the nature of this ſalt has not been examined.

13. Tartrate of Potaſh and Tin.

This triple ſalt may be obtained by boiling together the oxide of tin and tartar, in water. It is a ſoluble ſalt, and cryſtallizes with difficulty. It is not precipitated by the alkalies or the alkaline carbonates.

14. Benzoate of Tin.

This ſalt is formed by adding to a ſolution of tin in muriatic acid, benzoate of potaſh. The benzoate of tin is precipitated, which is ſoluble in water, with the aſſiſtance of heat.

15. Succinate of Tin.

The oxide of tin is diſſolved by ſuccinic acid with the aſſiſtance of heat. When the ſolution is evaporated, it affords thin tranſparent cryſtals of ſuccinate of tin.

II. Action of Alkalies, &c. on Tin.

1. Tin in the metallic ſtate is little changed by the action of the alkalies; but the oxides of tin readily combine with theſe bodies. The combination of the oxide of tin with the fixed alkalies is effected, either in the dry or humid way; and with the aſſiſtance of heat the oxide of tin combines with liquid ammonia. This combination takes place moſt readily when the oxide is recently precipitated, when it is in the ſtate of minute diviſion. 1511 Alkalies.

2. The oxide of tin combines with the earths by fuſion; and with the addition of a fixed alkali, forms an opaque vitreous maſs, which is employed for the purpoſes of enamel. 1512 Earths.

3. Moſt of the ſalts are decompoſed by means of tin, 1513 Salts.
in conſequence of the ſtrong affinity of this metal for
oxygen. All the ſulphates, when heated with this
metal, are more or leſs rapidly converted into ſulphu-
rets. Equal parts of ſulphate of potaſh and tin, heated 1514 Sulphates.
together in a crucible, afford a greeniſh coloured maſs,
which has no metallic appearance, and which ſeems to
be a ſulphuret of potaſh and tin. The nitrates pro- 1515 Nitrates.
duce

duce deflagration with this metal, with the aſſiſtance of heat. If the tin be melted in a crucible, and brought to a red heat, and dried nitre in powder be projected into it, a white brilliant flame is produced, and when the detonation has entirely ceaſed, the tin is found to be oxidated. This experiment may be alſo made, by mixing together tin filings with three parts of nitre in powder, and projecting the mixture into a red-hot crucible. 1816 Muriates. Muriate of ammonia is decompoſed by tin; and by adding ſulphur, the ſulphurated oxide of tin, or *aurum muſivum*, is obtained. Eight parts of tin united to eight parts of mercury, with ſix of ſulphur, and four of muriate of ammonia, afford, according to the proceſs of Pelletier, a very beautiful *aurum muſivum*.

It was obſerved by this philoſopher, that during the proceſs, ſulphurated hydrogen gas, ſulphuret of ammonia, and muriate of tin, were produced; that the tin oxidated and united to the ſulphur, formed aurum muſivum; and that a part of this matter, compoſed of the different ſubſtances, in a ſtate of vapour, was depoſited in lamellated, hexangular cryſtals, in the upper part and in the neck of the retort.

The alkaline hyperoxymuriates, but eſpecially that of potaſh, produce a violent detonation with this metal. Three parts of this ſalt mixed with one of tin in fine powder, rapidly deflagrates when brought into contact with a burning body. During this combuſtion, there is a brilliant and ſudden flame, and the metal is reduced to the ſtate of vapour. The ſame mixture by percuſſion produces a violent detonation with a conſiderable flame in the dark.

Many of the metallic ſolutions and metallic ſalts are decompoſed by means of tin, and are either reduced to the metallic ſtate, or deprived of a conſiderable portion of their oxygen.

III. Alloys.

1817 Arſenic. 1. Tin and arſenic form an alloy by fuſion. The compound, when the proportion of arſenic is conſiderable, is white, brittle, more ſonorous and harder than tin. In the proportion of 15 parts of tin and one of arſenic, the alloy cryſtallizes in large plates, is more infuſible than tin, and more brittle than zinc. By expoſure to the air, and with the aſſiſtance of heat, the arſenic is driven off.

1818 Cobalt. 2. With cobalt tin forms an alloy which is in ſmall grains, and of a light violet colour.

1819 Biſmuth. 3. Tin combines with biſmuth. The tin is then harder, more ſonorous and brighter. The compound in certain proportions becomes more fuſible than either of the two metals. The alloy of equal parts of tin and biſmuth melts at 280°. Eight parts of tin and two of biſmuth melt at 390°, and two of tin and one of biſmuth at 330°.

1820 Antimony. 4. Tin combines with antimony, and forms an alloy which is white and brittle, and has a ſpecific gravity leſs than that of the two metals taken ſeparately. The antimony gives hardneſs to the tin, and changes its texture. This alloy is employed in many arts, and particularly for the plates on which muſic is engraved.

1821 Mercury. 5. Tin combines very readily with mercury, and in all proportions. The tin is even diſſolved when the quantity of mercury is conſiderable. This union takes place in the cold, but it is greatly promoted by means of heat. The heated mercury is poured upon the tin in fuſion. The amalgam of tin is ſuſceptible of cryſtallization in the form of cubes. Sage obſerved the cryſtals of this amalgam in gray brilliant plates, thin towards the edges, and leaving between them polygonal cavities.

This amalgam is employed for covering mirrors. In applying it, tinfoil is ſpread on a ſmooth flat ſtone or table, and mercury, in which a certain proportion of tin has been already diſſolved, is poured upon it. It is then ſpread equally over the whole with a feather or a piece of cloth. The plate of glaſs, one ſide of which is to be covered, is then applied to the edge of the table, and cautiouſly moved along the tinfoil, ſo that the redundant part of the mercury may be carried before it. What remains enters into union with the tin. The glaſs is then to be equally loaded with weights, to preſs out any part of the mercury which may yet remain uncombined with the tin. In the courſe of a few hours the amalgam of the two metals adheres ſo firmly to the glaſs, that the weights may be removed.

1822 Zinc. 6. Zinc readily forms an alloy with tin by fuſion. The compound affords a hard metal with ſmall grains, the ductility of which correſponds to the quantity of tin. The alloy of tin and zinc forms part of the compound which is known by the name of *pewter*.

1823 Uſes. Tin is applied to a great many important purpoſes. In the arts and domeſtic economy, it is formed into a great variety of veſſels and inſtruments. The alloys of tin with other metals are not leſs important. It forms a component part of type metal, and bell metal. The oxides of tin are employed for the purpoſe of poliſhing glaſs and metallic ſubſtances, and combined with the earths and alkalies for the fabrication of enamels. The ſalts of tin are employed for the preparation of colours in dyeing, or as a valuable mordant for fixing certain colours. Tin in the metallic ſtate has been exhibited as a remedy againſt worms. It is then granulated by conſtant agitation while it cools after fuſion; but it is ſuppoſed, if it produces any effect as a vermifuge medicine, that it is merely by its mechanical action.

Sect. XVII. *Of Lead and its Combinations.*

1824 Hiſtory. 1. Lead has been known from the earlieſt ages. Pliny ſpeaks of it under the name of black lead, probably to diſtinguiſh it from tin, with the properties of which he was alſo acquainted, for he obſerves that it was ſometimes the practice to contaminate tin with lead.

1825 Ores. 2. Lead is found in great abundance in many parts of the world, and in a great variety of forms and combinations. Lead has rarely, if ever, been found native, and it is doubted whether it has yet been diſcovered in the ſtate of oxide. The moſt common form of lead is in the ſtate of ſulphuret, when it is combined with ſulphur. In this ſtate it is of a gray, brilliant colour, of a lamellated texture, very brittle, and breaks into cubes. This is the moſt frequent combination of lead, and it is generally found in this ſtate in veins. Lead is alſo frequently met with combined with ſeveral of the acids. The carbonate, phoſphate, and arſeniate of lead are not uncommon productions in the cavities of the veins of ſulphuret of lead. The chromate, molybdate, and ſulphate of lead, are more rare.

1826 Analyſis. 3. The ſulphuret of lead, which is the moſt common ore, is reduced by roaſting, and then fuſing with black flux. The other ores of lead are to be analyzed according to the nature of the acid with which they are combined. To obtain lead in a ſtate of purity, it may be diſſolved in nitric acid, and precipitated by means of ſulphate of ſoda. The precipitate, which is ſulphate of lead, is well waſhed, and reduced in a crucible, by fuſing it with three times its weight of black flux.

1827 Properties. 4. Lead is of a grayiſh or bluiſh white colour. It has conſiderable brilliancy, but it ſoon tarniſhes when expoſed to the air. The ſpecific gravity of lead is 11.352. It gives out a peculiar odour when it is rubbed; it has at firſt ſcarcely any perceptible taſte; but a diſagreeable impreſſion after ſome time remains on the tongue. When it is taken internally, it produces violent effects on the animal economy, even in very ſmall quantity. The colica pictonum or dry bellyach of the Weſt Indies, or, as it is called in this country, *mill-reek*, which is a violent affection of the bowels, is occaſioned by this metal being taken internally, either combined with ſome liquid, or in the ſtate of vapour. This terrible diſeaſe often terminates in palſy. Lead ſtains the finger or paper of a bluiſh colour. It is one of the ſofteſt of the metals. It may be ſcratched with the nail or cut with a knife. It poſſeſſes conſiderable malleability, and may be reduced to plates thinner than paper. It has no great ductility, and its tenacity is leſs than that of the other metals. A lead wire of about $\frac{1}{12}$ of an inch in diameter can ſupport only a weight of about 18lb.

1828 Action of heat. 5. Lead is very fuſible. It melts at the temperature of 540°, or, according to the eſtimation of Guyton, at 594°. When it is kept a long time melted, and at a red heat, it ſublimes, and evaporates in the air. By ſlow cooling it cryſtallizes in quadrangular pyramids compoſed of octahedrons.

1829 Oxidation. 6. When lead is expoſed to the air, it ſoon tarniſhes, is deprived of its luſtre, and becomes firſt of a deep gray, and afterwards of a grayiſh white colour; but this proceſs is extremely ſlow, for the white cruſt which is formed on the ſurface defends the metal from the action of the air, and its farther oxidation by abſorption of oxygen.

When lead is melted in the open air, and heat continued, an irideſcent pellicle is formed on the ſurface, which afterwards aſſumes a uniform gray colour. When this is removed, another pellicle is formed, and in this way the whole may be converted into an oxide. 1830 Gray oxide. When theſe pellicles are heated and agitated together, the whole is converted into a grayiſh powder, mixed with yellowiſh or greeniſh ſpots. This is the gray oxide of lead, which is the firſt ſtate of its oxidation.

1831 Yellow. When the gray oxide of lead is more ſtrongly heated in contact with air, it abſorbs a greater quantity of oxygen, and is converted into a yellow oxide, which is known in the arts by the name of *maſſicot*. It contains about nine parts of oxygen in the hundred. This oxide, which is much employed in ſome of the arts, is prepared in the large way, by conſtantly agitating it while heated, in contact with air, without applying ſo great a heat as to reduce the metal to the ſtate of the next oxide.

1832 Red. If this oxide of lead be reduced to a fine powder, and expoſed to a ſtrong heat in a furnace for about 50 or 60 hours, it is converted into a red powder, which is well known by the name of *minium*, or *red lead*. The heat neceſſary for this converſion is that of a cherry-red, in a reverberatory furnace.

1833 Brown. Lead is ſuſceptible of combining with another portion of oxygen, and of forming another oxide. If a quantity of red oxide of lead, according to the proceſs of Prouſt and Vauquelin, be put into a veſſel with water, and oxymuriatic acid gas be paſſed through it, the oxide aſſumes a deeper colour, and is diſſolved. By adding potaſh to the ſolution, the lead is precipitated of a brown colour, which is the brown oxide of lead. It is of a ſhining brown colour, and is compoſed of

Lead	79
Oxygen	21
	100

By the action of the blow-pipe it becomes yellow, and melts. On burning coals it is reduced, and when heated in a retort, gives out pure oxygen gas, and is converted into a vitreous matter. It inflames ſulphur by triturating it with the oxide, and gives out a bright flame.

1834 Litharge. 7. When lead has been converted into an oxide, and when this oxide is expoſed to a more violent heat, it melts into a kind of glaſs, or ſemivitrified matter. In this ſtate it is known by the name of *litharge*. It conſiſts of ſmall reddiſh brilliant ſcales, which from the colour is called *litharge of gold*. When it has been expoſed to a greater degree of heat, and is more vitrified, it is diſtinguiſhed by the name of *litharge of ſilver*.

8. There is no action between lead and azote, hydrogen or carbone. Water has no action on lead, but it ſeems to promote the oxidation of this metal, when it is in contact with air. Leaden veſſels which are frequently moiſtened with water, are covered with a white cruſt when expoſed to the air.

1835 Phoſphuret. 9. Lead combines with phoſphorus, and forms with it a phoſphuret. This may be prepared by projecting phoſphorus on lead melted in a crucible, or by diſtilling phoſphorus with lead in a retort. The phoſphuret of lead is of a ſilvery white colour, with a little of a bluiſh ſhade. It is of a lamellated ſtructure, and may be ſeparated in plates by hammering. It is ſo ſoft that it may be cut with a knife. It is ſomewhat leſs fuſible than the component parts. During its fuſion, a ſmall quantity of phoſphorus ſeparates, and takes fire on the ſurface. The component parts of this phoſphuret are,

1836 Compoſition.

Lead	88
Phoſphorus	12
	100

1837 Sulphuret. 10. Sulphur combines readily with lead, either by melting ſulphur and lead together in a crucible, or by throwing ſulphur on melted lead. A black matter is thus obtained, of a brilliant appearance, fibrous texture, and leſs fuſible than lead. This compound is brittle, and reſembles the native ſulphuret of lead, or *galena*. The component parts of this ſulphuret are,

Lead	86.8
Sulphur	13.2
	100.0

1838
Affinities.

11. Lead enters into combination with the metals, and forms alloys, and with the acids, and forms ſalts. The order of the affinities of lead and of its oxide is the following:

Lead.	Oxide of Lead.
Gold,	Sulphuric acid,
Silver,	Saclactic,
Copper,	Oxalic,
Mercury,	Arſenic,
Biſmuth,	Tartaric,
Tin,	Muriatic,
Antimony,	Phoſphoric,
Platina,	Sulphurous,
Arſenic,	Suberic,
Zinc,	Nitric,
Nickel,	Fluoric,
Iron,	Citric,
Sulphur.	Lactic,
	Acetic,
	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Lead.

1. Sulphate of Lead.

1839
Prepara-
tion.

Sulphuric acid has no action on lead in the cold, but when lead is boiled with the acid concentrated, it decompoſes it, and ſulphurous acid gas is diſengaged with effervеſcence. The lead is converted into a white thick maſs, which remains at the bottom of the veſſel. Sulphate of lead may alſo be obtained by adding ſulphuric acid or an alkaline ſulphate to acetate of lead. This ſalt is precipitated in the ſtate of a white powder. The white maſs obtained by the firſt proceſs, being waſhed with water, ſeparates into two portions, one of which is oxide of lead containing a little ſulphuric acid, and the other portion, which is ſulphate of lead, is ſoluble in water, and may be obtained cryſtallized in needles. The ſpecific gravity of this ſalt is 1.8742. It has ſcarcely any taſte. It is found native, and cryſtallized in regular octahedrons, or four-ſided pyramids, or tranſparent tables. The component parts of native ſulphate of lead are, according to

1840
Compoſition.

	Kirwan.	Klaproth.
Oxide	75.00	70.50
Acid	23.37	25.75
Water	1.63	2.25
	100.00 *	98.50 †

This ſalt is deprived of great part of its acid by means of the alkalies.

2. Sulphite of Lead.

1841
Prepara-
tion.

Sulphurons acid has no action on lead, but it combines readily with the oxide of lead, with a ſmaller proportion of oxygen. The red oxide of lead added to liquid ſulphurous acid, ſoon becomes white; the acid is deprived of its colour, and there is formed a ſaline maſs of ſulphate and ſulphite of lead. The ſulphite of lead cannot be obtained ſeparately, but by treating the white oxide of lead ſeparated from the nitrate by means of ſulphurous acid. The ſulphite of lead is taſteleſs and inſoluble. By the action of the blow-pipe on charcoal, it melts, gives out a phoſphoric flame, and becomes of a pale yellow colour on cooling. When it is heated for a longer time, it ſwells up and is entirely reduced to the metallic ſtate. When diſtilled in cloſe veſſels, it gives out water, ſulphurous acid, and ſulphur, and there remains behind, ſulphate of lead of a greeniſh yellow colour. It is decompoſed with effervеſcence and the evolution of ſulphurous acid, by means of ſulphuric and muriatic acid. It is not decompoſed by nitric acid, but is converted into a ſulphate, and red fumes of nitrous gas are given out. If, in place of treating the red oxide with ſulphurous acid, this oxide be expoſed to a red heat, along with ſulphite of ſoda, the oxide is reduced, and the ſulphite of ſoda is converted into a ſulphate, but with exceſs of ſoda, becauſe the ſulphuric acid formed, cannot ſaturate the ſame quantity of ſoda. Hence it appears, that the red oxide of lead gives up part of its oxygen to the ſulphurous acid when it is uncombined, and the whole of its oxygen to the acid, when it is in combination with potaſh or ſoda *.

1842
Action of
heat.

1843
Decompoſition.

3. Nitrate of Lead.

1844
Prepara-
tion.

1. Nitric acid, a little diluted with water, acts upon lead, oxidates it, and diſſolves it with effervеſcence. If the acid be too ſtrong, there remains behind a dry oxide. This oxide is equally ſoluble in nitric acid. No precipitate is formed in the ſolution by the addition of water. It has at firſt a ſweetiſh, then an aſtringent, acid taſte. By evaporatng the ſolution, it affords on cooling, regular cryſtals in the form of flat triangles; and by ſlow, ſpontaneous evaporation, the angles are truncated. Sometimes ſix-ſided truncated pyramids are obtained, with the faces alternately broad and narrow. Theſe cryſtals decrepitate ſtrongly on burning coals, and give out brilliant ſparks. The ſalt is decompoſed, and a yellow or red oxide of lead remains behind. Nitrate of lead is decompoſed by the alkalies, and precipitated in the form of white oxide. It is precipitated of a black colour, by means of the ſulphurets and hydroſulphurets; it is alſo decompoſed by ſulphuric acid and the ſulphates, which form a thick, white, ſoluble precipitate of ſulphate of lead. Sulphurous acid alſo precipitates this ſalt in the form of ſulphate of lead.

1845
Properties.

1846
With the
white oxide.

2. The former ſalt is a compound of nitric acid and the yellow oxide; but when nitric acid combines with the white oxide, the ſalt cryſtallizes in yellow coloured brilliant ſcales, which are very ſoluble in water. This ſalt may alſo be prepared by boiling together a quantity of nitrate of lead with the yellow oxide, along with lead in the metallic ſtate. The lead deprives the yellow oxide of part of its oxygen, and the whole is converted into the white oxide, and combines with the acid.

1847
Action on
red oxide.

3. But if nitric acid be poured on the red oxide of lead, heat is produced, the oxide becomes white, part is diſſolved, and part falls to the bottom in the form of

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* Min. Wat p. 9.

† Eſſays, ii. Tranſ.

* Fourc oy, viii. 86.

a black powder. This powder is the brown oxide of lead, with the greateſt proportion of oxygen, part of which it has derived from the red oxide, which is then converted into the white. About $\frac{6}{7}$ of the red oxide are diſſolved in the acid, but are previouſly reduced to the ſtate of white oxide, and the oxygen which has been given out, combines with the remaining $\frac{1}{7}$, and converts it to the ſtate of brown oxide. Thus it appears, that the red and the brown oxides of lead do not form compounds with nitric acid. They muſt be deprived of a portion of their oxygen, and converted into the white or yellow oxides, before they are ſoluble in this acid.

4. Muriate of Lead.

1849 Preparation. 1. Muriatic acid acts feebly on lead or its oxide; but when it is heated with the latter, part of the oxide combines with the acid, becomes ſoluble with exceſs of acid, and affords cryſtals in the form of ſhining ſilky needles, which are not deliqueſcent in the air, but are ſoluble in water, and have an aſtringent taſte. This ſalt may be formed by adding an alkaline muriate to a ſolution of nitrate of lead. A white thick precipitate is immediately formed. The muriate of lead thus obtained, has a ſweetiſh taſte, and is ſoluble in about 30 times its weight of water. When heated, it readily melts, and gives out a white vapour, which condenſes into a cryſtalline powder. When this ſalt is melted, it aſſumes the appearance of a ſemivitreous, ſhining, grayiſh maſs, which has been called *plumbum corneum*, 1848 Compoſition. or *horny lead*. This ſalt is decompoſed by ſulphuric acid. Its component parts are, according to

Klaproth.		Kirwan.	
Acid,	13.5	Acid,	18.23
Oxide of lead,	86.5	Oxide of lead,	81.77
	100.0		100.00

1849 With red oxide. 2. When muriatic acid is ſlightly heated with the red oxide of lead, the acid is converted into oxymuriatic acid; while the oxide, deprived of part of its oxygen, unites to another portion of the acid, and forms muriate of lead in the ſtate of white powder.

5. Hyperoxymuriate of Lead.

When oxymuriatic acid gas is made to paſs through water, having a white, yellow, or red oxide of lead, it is 1850 Preparation. abſorbed. The oxide becomes at firſt black or brown, and is then diſſolved. The hyperoxymuriate which is formed, remains in ſolution of a yellow colour. This ſolution being precipitated with potaſh or ſoda, the oxide of lead is depoſited, of a reddiſh brown colour. This ſalt may be obtained by pouring oxymuriatic acid on nitrate of lead. No precipitate is at firſt formed, but in the end a browniſh red powder appears. This ſalt is more ſoluble than muriate of lead, and is readily decompoſed. The brown oxide of lead, which is ob- 1851 Properties. tained by decompoſing this ſalt, according to the experiments of Vauquelin, poſſeſſes very different properties from thoſe of the other oxides of this metal. It is of a deep, ſhining, velvet-brown colour. Heated with the blow-pipe, it becomes yellow, and melts. On red-hot coals it is reduced; it gives out pure hydrogen gas, when it is heated in a retort, and there remains behind a litharge of lead. It diſſolves in nitrous acid, but is inſoluble in nitric acid. The addition of ſugar, honey, or ſome vegetable matter, by depriving it of part of its oxygen, renders it ſoluble in this acid.

6. Fluate of Lead.

This ſalt may be formed by pouring a ſolution of an alkaline fluate into a ſolution of nitrate of lead. An inſoluble inſipid ſalt is thus formed, which is decompoſed by ſulphuric, nitric, and muriatic acids.

7. Borate of Lead.

This ſalt is formed in the ſame way as the laſt, and is in the ſtate of white powder. It melts before the blow-pipe, into a colourleſs glaſs.

8. Phoſphate of Lead.

1. Liquid phoſphoric acid acts very ſlowly upon lead, and converts it into a white, inſoluble phoſphate. 1852 Preparation. It may be formed, however, by adding an alkaline phoſphate to the nitrate of lead. With an exceſs of acid this ſalt becomes fuſible by heat, and when it cools, aſſumes the form of regular polyhedrons. It is decompoſed by red-hot charcoal, which converts it into phoſphorus and lead, while the carbone of the charcoal is converted into carbonic acid. It is decompoſed by ſulphuric, nitric, and muriatic acids, and by the alkaline carbonates.

2. This ſalt is frequently found native, cryſtallized in 1853 Native. ſix-ſided priſms, of a green or yellow colour. It is ſoluble in pure ſoda, but inſoluble in water. The component parts of a phoſphate of lead from Wanlockhead in Scotland, according to the analyſis of Klaproth, are the following.

Oxide of lead,	80.00
Phoſphoric acid,	18.00
Muriatic,	1.62
	99.62 *.

9. Carbonate of Lead.

1854 Preparation. 1. Carbonic acid which has no action on lead, combines with its oxide, which is converted into the carbonate of lead; or this ſalt may be prepared by the decompoſition of a ſoluble ſalt of lead by an alkaline carbonate. Thus precipitated, it is in the ſtate of white powder, which has neither taſte nor ſmell, and is inſoluble in water, but it is ſoluble in pure potaſh.

1855 Native. 2. This ſalt is frequently found native, of a whitiſh colour, and cryſtallized in tables, in ſix-ſided priſms, or in regular octahedrons. The ſpecific gravity is 7.2357. It is inſoluble in water. By the action of the blow-pipe on charcoal, the acid is driven off, and the lead is revived. The component parts of carbonate of lead, are, according to

	Bergman.	Klaproth.
Acid,	16	16.33
Yellow oxide,	84	83.67
	100	100.00

1856 White lead. 3. Ceruſe or white lead, which is employed as a paint, is a carbonate of lead, combined with a certain proportion of oxide. It is prepared by expoſing thin plates of lead to the vapour of vinegar. A range of pots are placed on tanners bark or horſe dung, that they may receive a moderate heat. Theſe are covered with plates of lead, which are full of holes. Another range of pots is placed above theſe, covered in like manner with plates of lead, and ſo on, till the whole chamber is filled. The acid is decompoſed; part of the lead remains in the ſtate of oxide, while the greateſt proportion is converted into a carbonate, which is the white lead of commerce.

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* *Eſſays*, ii 155. *Tranſl.*

10. Arſeniate of Lead.

When lead is digeſted in a ſolution of arſenic acid, the ſurface is blackened, and becomes covered with a white powder. When lead filings are diſtilled with double their weight of ſolid arſenic acid, the mixture melts into a tranſparent maſs. A ſmall quantity of arſenious acid is ſeparated, and there remains behind a whitiſh glaſs, which being diluted with water, lets fall a white powder, whilſt part of the arſenic acid is diſſolved. The lead in this caſe has deprived the arſenic acid of part of its oxygen, and in the ſtate of white oxide has combined with another portion of the acid. The arſeniate of lead is not ſoluble in water. By heat it fuſes into a white glaſs. This ſalt is found
1827 Compoſition. native, and by the analyſis of Mr Chenevix it is compoſed of

Acid,	33
White oxide,	63
Water,	4
	100

11. Tungſtate of Lead.

Tungſtic acid ſeparates the oxide of lead from its ſolution in nitric acid, and forms a tungſtate of lead, in the form of a white powder.

12. Molybdate of Lead.

When molybdic acid is added to the ſolution of lead in nitric acid, it forms a copious white precipitate, which is molybdate of lead. This ſalt is found native, and cryſtallized in cubes or rhomboidal plates. It is of a yellow colour, inſoluble in water, but ſoluble in fixed alkalies and nitric acid. It is decompoſed by muriatic acid. The component parts, as aſcertained by Klaproth, are,

Acid,	34.7
Oxide,	65.3
	100.0

13. Chromate of Lead.

An alkaline chromate mixed with the ſolution of nitrate of lead, forms a precipitate in the ſtate of red powder, which is chromate of lead. This ſalt is found native, of a reddiſh yellow colour, and cryſtallized in four-ſided priſms, terminated by four-ſided pyramids. The ſpecific gravity is about 6. It is ſoluble in the fixed alkalies, but inſoluble in water. It is decompoſed by muriatic and ſulphuric acids, but diſſolves without decompoſition in nitric acid. According to the analyſis of Vauquelin, it is compoſed of

Acid,	34.9
Oxide,	65.1
	100.0

14. Acetate of Lead.

1858 Names. 1. The combination of acetic acid and lead was formerly known by the names of *extract of Saturn*, *ſalt of Saturn*, *ſugar of Saturn*, or *ſugar of lead*. This acid oxidates lead, and diſſolves the oxides with great facility. 1859 Preparation. It is formed by diſſolving carbonate of lead or ceruſe in acetic acid, or by expoſing thin plates of lead to the action of acetic acid in earthen veſſels. After the acid is ſufficiently ſaturated, and the ſolution concentrated by evaporation, the acetate of lead is depoſited in ſmall cryſtals.

1860 Properties. 2. This ſalt is in the form of ſmall cryſtals, which are flat, four-ſided priſms, terminated by two-ſided ſummits. It has an aſtringent ſweetiſh taſte. The ſpecific gravity is 2.345. It is not very ſoluble in water, without an exceſs of acid. It undergoes no change by expoſure to the air. By its ſolution in water, a ſmall quantity is depoſited in the form of white powder, which is a carbonate of lead, formed by the carbonic acid which exiſts in the water.

1861 Decompoſition. 3. Acetate of lead is decompoſed by ſulphuric, muriatic, fluoric, and phoſphoric acids. It is decompoſed by heat. By diſtillation it affords, according to the experiments of Prouſt, from 160 parts of the ſalt, 12 parts of ſlightly acidulated water; with a greater heat, 72 parts of a yellow liquid, having the odour of alcohol, which had ſomething of an empyreumatic ſmell. Ammonia was diſengaged, by adding lime to the liquid; and when the liquid was ſaturated with potaſh, and remained at reſt for 24 hours, a third part of oil ſeparated, and floated on the ſurface. This oil, which had a ſtrong odour, was removed, and the liquid diſtilled with a moderate heat. The firſt part that came over mixed with water like alcohol, and was almoſt as volatile as ether. When it was brought into contact with a burning body, it gave out a white flame.

15. Oxalate of Lead.

Oxalic acid very readily tarniſhes lead, and at laſt corrodes it. It readily diſſolves the oxide; and when it is ſaturated, the ſolution becomes thick, and depoſits ſmall ſhining cryſtals, which become readily opaque by expoſure to the air. This ſalt may be formed by pouring oxalic acid into the ſolutions of nitrate, muriate, or acetate of lead. It is ſcarcely ſoluble in water, without an exceſs of acid. The component parts are,

Acid,	41.2
Oxide,	58.8
	100.0

16. Tartrate of Lead.

Tartaric acid combines with the oxide of lead, or forms a precipitate in the ſtate of an inſoluble white powder, from the ſolution of lead in nitric and muriatic acids. It is compoſed of

Acid,	34
White oxide,	66
	100*.

17. Tartrate of Potaſh and Lead.

This triple ſalt is obtained by boiling the oxide of lead in tartar with water. It is inſoluble, and is not decompoſed by the alkalies.

18. Citrate of Lead.

By adding citric acid to a ſolution of acetate of lead, a citrate of lead precipitates in the form of powder, which is ſcarcely ſoluble in water.

19. Malate of Lead.

This ſalt is obtained by adding malic acid to a ſolution of the nitrate or acetate of lead. The malate of lead precipitates in the form of fine light flakes. It is ſoluble in acetic and diluted nitric acids.

20. Benzoate of Lead.

Benzoic acid has but a feeble action on lead. By evaporating the ſolution, cryſtals of a brilliant-white colour are obtained, which are benzoate of lead. This ſalt undergoes no change by expoſure to the air, is ſoluble in water and alcohol, is decompoſed by heat, and by the ſulphuric and muriatic acids.

21. Succinate of Lead.

Succinic acid combines with the yellow oxide of lead, and yields ſlender foliated cryſtals, which are nearly inſoluble in water, but ſoluble in nitric acid.

22. Saccolate of Lead.

When ſaclactic acid is added to ſolution of nitrate of lead, a white precipitate is obtained, which is ſaccolate of lead.

23. Suberate of Lead.

Suberic acid forms a precipitate when added to the ſolution of lead in acetic and nitric acids.

24. Lactate of Lead.

Lactic acid, after it has been digeſted upon lead for ſome days, diſſolves a portion of it. The ſolution has a ſweet, aſtringent taſte, but it does not cryſtallize.

II. Action of the Alkalies, &c. on Lead.

1862 Promote its oxidation. 1. The alkalies and earths have no action whatever on lead. The alkalies, however, promote its oxidation by the air, on account of the attraction which they poſſeſs for the oxide of lead.

1863 Combine with the oxide. 2. The alkalies and alkaline earths unite readily with the oxide of lead. Lime water digeſted ſome time with oxide of lead in the ſtate of litharge, diſſolves this oxide better than the red. When the ſolution is evaporated, it affords ſmall, tranſparent, irideſcent cryſtals, not more ſoluble than lime. The alkaline ſulphates decompoſe this compound of oxide of lead and lime. It is alſo decompoſed by ſulphurated hydrogen gas, and by ſulphuric and muriatic acids, which latter convert the lead into a ſulphate and muriate. This ſolution blackens wool, the nails, hair, the white of an egg; but has no action, and produces no change on ſilk, on the ſkin, or the yolk of an egg. It has been obſerved, that the ſimple mixture of red oxide of lead and of lime, which latter converts it to white, produces a black colour on animal matters. It is ſometimes employed for dyeing the hair. It had formerly been obſerved by Bergman, that the cauſtic fixed alkalies diſſolve the oxide of lead, which takes place when theſe bodies are added in exceſs to the precipitates of this metal from its ſolution.

1864 Earths. 3. The earths, but eſpecially alumina and ſilica, readily combine with the red oxide of lead, by the action of heat; and, when the proportion of oxide is conſiderable, the compound is a heavy, uniform, vitreous maſs, which has been called *glaſs of lead*. It is on account of the ſtrong tendency of the oxide of lead to vitrification, and which it communicates to earthy matters, that it is employed in the compoſition of glaſs in the proportion of from $\frac{1}{5}$ to $\frac{1}{6}$. This oxide was only employed formerly, for the preparation of enamels, and for glazing pottery and ſtone ware; but it is now generally uſed after the example of the Engliſh manufacturers, in the fabrication of glaſs, in moſt countries of Europe.

1865 Sulphates, &c. 4. Lead has no action on the ſulphates. It burns ſlowly with the aſſiſtance of the nitrates. When nitre, in the ſtate of fine powder, is thrown into melted lead, raiſed to a red heat, there is ſcarcely any perceptible flame; and, when the action has ceaſed, the oxide is found in ſmall yellowiſh ſemivitrified ſcales, ſimilar to thoſe of litharge.

1866 Muriates. 5. There is a perceptible action between lead and the muriates, ſome of which have given riſe to ſeveral important proceſſes in chemiſtry, and in the arts. It had been long obſerved, that a plate of lead immerſed in water, ſaturated with muriate of ſoda, was ſoon covered with a cruſt of white oxide. It was alſo known, that the red oxide of mercury and litharge became white when kept in contact with muriate of ſoda diſſolved in water. This proceſs, which is promoted by agitation, is one of the great deſiderata of modern chemiſtry, to be able to decompoſe common ſalt for the purpoſe of obtaining the ſoda. It was at firſt ſuppoſed, that this was a partial decompoſition, from which a ſmall quantity of muriate of lead only was obtained; that the decompoſition was aided by heat; and that it was by this proceſs that a brilliant yellow muriate of lead, much employed in painting under the name of *Engliſh yellow*, was prepared.

1867 Decompoſition of muriate of ſoda. This ſubject has been greatly elucidated by the experiments and reſearches of Vauquelin. He took ſeven parts of litharge reduced to powder, and one of muriate of ſoda mixed together, and moiſtened with a ſufficient quantity of water, to reduce them to the liquid ſtate, and then agitated the mixture for ſeveral hours to promote the reciprocal action. The oxide became white, and increaſed in volume, and the mixture abſorbing the water, became of a more ſolid conſiſtence. Having added new quantities of water during four days, and diluted the whole in ſeven or eight parts of this liquid, it was filtered. The liquid, which was now ſenſibly alkaline, contained a little muriate of lead, but no trace of muriate of ſoda. When it was evaporated to $\frac{1}{10}$ of its bulk, it yielded cryſtals of carbonate of ſoda, which were opaque, by being contaminated with muriate of lead. The oxide of lead which remained, had increaſed about $\frac{1}{8}$ of the weight; it became of a fine citron-yellow colour, with a moderate heat, and loſt 0.025 of its weight. It was inſoluble in water. Soda diſſolved a portion of this oxide, as did alſo diluted nitric acid. By this means the muriate of lead was ſeparated pure and cryſtallized; and the maſs which remained after the action of muriate of ſoda and lead, exhibited the characters of a muriate of lead containing an exceſs of oxide.

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* Ann. de Chim. xxviii. 37.

From theſe experiments Vauquelin concludes, that the litharge which has been employed in the decompoſition of ſea ſalt, is a muriate of lead with exceſs of oxide; that the cauſtic alkalies diſſolve this ſalt, but do not decompoſe it; that the affinity of muriate of lead for an exceſs of the oxide of this metal, is the cauſe of the decompoſition of muriate of ſoda by means of litharge; that the exceſs of oxide gives to the muriate of lead the property of aſſuming a brilliant yellow colour by heat, a property which the ſimple muriate of lead does not poſſeſs; that the ſame exceſs of lead renders it inſoluble in water, and that this exceſs may be taken up by the nitric acid, which reduces it to the ſtate of ordinary muriate of lead. The ſame philoſopher has confirmed theſe inferences, by ſhewing that cauſtic ſoda decompoſes the common muriate of lead, only by bringing it to the ſtate of muriate with exceſs of oxide, which is characterized by being in the form of powder, and the yellow colour, which is communicated by heat, and its decompoſition by nitric acid, which converts it into nitrate of lead, and ſimple muriate of lead. Thus, it appears, that the oxide of lead decompoſes the muriate of ſoda, by double affinity; namely, by the affinity of the oxide for muriatic acid, and that of the muriate of lead for an exceſs of oxide. A conſiderable quantity of the latter, therefore, is neceſſary for the complete decompoſition. Five-ſixths, at leaſt, are required to form the muriate with exceſs of oxide. Litharge then decompoſes ſea ſalt completely, when in ſufficient quantity, while ſoda only decompoſes the muriate of lead partially, and reduces it to the ſtate of muriate with exceſs of oxide; but the carbonate of ſoda effects the entire decompoſition of this ſalt.

1686 Muriate of ammonia.

6. The decompoſition of muriate of ammonia by lead, and eſpecially by its oxide, has been long known. The oxides of lead triturated with this ſalt in a mortar in the cold, diſengage ammonia, which is very perceptible by its ſmell. By diſtilling a mixture of one part of red oxide of lead and two of muriate of ammonia in a retort, very pure cauſtic ammonia is obtained. If the red oxide has remained for any length of time expoſed to the air, it gives out, during the proceſs, a little carbonate of ammonia. The hyperoxymuriate of potaſh produces a detonation with lead. A mixture of three parts of this ſalt with one of lead, gives out a vivid flame by percuſſion. The other ſalts, as the phoſphates, fluates, &c. have no effect on lead. By the action of the blow-pipe, they combine with its oxides, and form yellowiſh, or gray, opaque, or tranſparent glaſſes.

III. Alloys.

1869 With arſenic. 1. Lead combines with arſenic by fuſion, and the compound is a brittle lamellated alloy. When the oxides of theſe metals are combined together by means of heat, a vitreous maſs of a red colour is formed.

2. The alloys of lead with tungſten, molybdena, and the newly diſcovered metals, are not known.

1870 Cobalt. 3. Cobalt ſeems to have little affinity for lead. Equal parts of the two metals being fuſed together, were found, when the maſs cooled, to be in ſeparate maſſes. The heavieſt metal occupied the inferior part of the veſſel, and the lighter the upper part. An alloy of lead and cobalt has been formed by introducing cobalt in powder within plates of lead and covering them with charcoal, to exclude the air. A brittle maſs, which aſſumed a better poliſh than lead, was obtained from equal parts of the two metals, by the application of heat. The two metals in different proportions afforded an alloy which differed in hardneſs, ſpecific gravity and malleability, according as the one or the other metal predominated.

1871 Biſmuth. 4. Lead forms with biſmuth an alloy of a cloſe grain, and a dark gray colour. This alloy, when the biſmuth is not in great proportion, poſſeſſes conſiderable ductility. Biſmuth has the property of increaſing the tenacity of lead. The ſpecific gravity of the alloy of lead and biſmuth is greater than the mean.

1872 Antimony. 5. When lead is combined with one-eighth of its weight of antimony, it forms an alloy which poſſeſſes great tenacity. When they are combined in equal parts, the alloy is very brittle. Two parts of lead with one of antimony, give a brittle alloy in ſmall grains ſimilar to thoſe of iron. Four parts of lead with one of antimony, afford an alloy of greater ductility, and in larger grains. Four parts of lead with one half of antimony, give a very ſoft metal in fine grains like ſteel, and having the ſame colour. The alloy of 16 parts of lead and one of antimony, differs only from lead in hardneſs. This alloy has a greater ſpecific gravity than the mean, and poſſeſſes conſiderable tenacity. It is employed in the fabrication of printing types.

1873 Mercury. 6. Mercury combines with lead very readily, and in all proportions. An amalgam of lead and mercury may be formed by triturating the former in filings with the latter; or, by adding heated mercury to lead in fuſion. This amalgam varies in ſolidity, according to the proportion of the two metals. It is of a white colour, is altered by expoſure to the air, and affords cryſtals by colouring. The mercury is driven off by ſtrong heat, and when it is triturated with water, a black powder, which is oxide of lead, ſeparates. The amalgam of lead and mercury becomes very liquid, when it is triturated with the amalgam of biſmuth. 1874 and biſmuth. To equal parts of lead and biſmuth melted in an iron veſſel, half the quantity of the whole maſs of hot fluid mercury was added, and the mixture was agitated till it cooled. A fluid amalgam was thus obtained, which does not become ſolid by reſt, or expoſure to the air, and which almoſt entirely paſſes through leather like mercury itſelf. This liquidity of lead and biſmuth is aſcribed to their increaſed capacity for caloric in a ſtate of combination. When mercury is thus ſophiſticated, it may be detected by obſerving the ſmaller ſpecific gravity, and ſubjecting it to the teſt formerly mentioned, of pouring it along a ſmooth ſurface, when it is found to *drag a tail*.

1875 Zinc. 7. An alloy of zinc and lead in equal parts is harder and whiter than lead, and is malleable. The lead is rendered volatile by the zinc, while the latter is in the proportion of 10 or 12 parts to one of the former; but if the zinc be in ſmaller proportion, it ſeparates from the lead. The ſpecific gravities of the alloys of zinc and lead are ſaid to be greater than the mean of the two metals.

1876 Tin. 8. Lead combines with tin in all proportions. Lead, in general, is found to increaſe in denſity and hardneſs, when alloyed with tin. Three or four parts of tin with one of lead, according to Muſchenbroek, form an alloy which poſſeſſes twice the hardneſs of pure tin. The alloy of three parts of tin and one of lead poſſeſſes the greateſt tenacity of any proportion of theſe metals. Two parts of lead and one of tin, compoſe an alloy which is more fuſible than either of the metals. This is the compoſition of common ſolder. 1877 Solder. Tinfoil is a compound of tin and lead; and the ſheet lead employed for lining the boxes in which tea is brought from China to Europe, contains a certain portion of tin, which gives it hardneſs. This, however, is alſo found to be alloyed with zinc and biſmuth.

1878 Tin and biſmuth. One of the moſt ſingular alloys of lead is that with biſmuth and tin, which has been called from its eaſy fuſibility, the *fuſible alloy*. Eight parts of biſmuth, five of lead, and three of tin, are the proportions propoſed by Darcet for this alloy, which is ſo fuſible, that it remains liquid at the temperature of boiling water. This alloy cryſtallizes by ſlow cooling.

1879 Uſes of lead, &c. Lead and its various preparations are applied to a great variety of purpoſes in the arts. In the metallic ſtate it is employed in the conſtruction of numerous veſſels. In the ſtate of oxide it is uſed as a paint, and in the fabrication of enamels for porcelain and pottery, and in the preparation of coloured glaſs and artificial precious ſtones. Some of its ſalts are of great importance in the arts, as the acetate in dyeing, and the carbonate or ceruſe in painting.

The greateſt caution ought to be obſerved, however, in the uſe of leaden veſſels in domeſtic economy, in which ſubſtances are preſerved which are to be taken internally, particularly thoſe which contain acids that are apt to diſſolve the lead; and as the effects of lead are ſo deleterious to the animal economy when taken internally, this caution cannot be too ſtrictly obſerved.

SECT. XVIII. *Of* IRON *and its Combinations.*

1880 Hiſtory. 1. Iron is one of the moſt important and moſt uſeful of the metals, and it is fortunately one of the moſt abundant. It is ſuppoſed that it was not ſo early known as ſome of the other metals, which, on account of their ſcarcity and durability, have been held in higher eſtimation, and dignified with the name of *precious metals*. But perhaps the difficulty of extracting and working iron prevented it from being ſo generally applied to thoſe purpoſes to which, on account of its valuable properties, it is peculiarly appropriated.

1881 Very abundant. 2. Iron, as it is the moſt uſeful of the metals, ſo, as it has been obſerved, it is the moſt abundant, and at the ſame time the moſt univerſally diffuſed. Iron exiſts in five different ſtates, but in theſe it exhibits the greateſt variety of any other of the metals. It is found in the metallic ſtate, in that of alloy with other metals; in the ſtate of ſulphuret, in the ſtate of oxide, and combined with the acids forming ſalts. 1882 Ores. 1. Iron has only been found native in inſulated maſſes, one of which, diſcovered by Pallas in Siberia, and another, which was found in South America, long occupied the attention of philoſophers in ſpeculations and diſcuſſions concerning their origin. This point remained unſettled till the diſcovery of numerous other facts with regard to ſimilar productions, which have proved, whatever may have been their origin or mode of formation, that theſe metallic maſſes have fallen from the atmoſphere. 2. Iron is frequently found in the ſtate of alloy with other metals; but in this ſtate it is generally in very ſmall proportion. 3. Combined with ſulphur. This compound, or ſulphuret of iron, which is known to mineralogiſts by the name of *pyrites*, is a frequent production among the ores of iron. Sulphuret of iron is found cryſtallized in a great variety of forms. Iron is alſo frequently found combined with carbone. This compound, now diſtinguiſhed by the name of *carburet of iron*, was formerly known by the name of *black lead*, or *plumbago*. 4. But the moſt ordinary ſtate of iron is that of oxide, and in this ſtate it exhibits a great variety of forms. It is ſometimes in irregular and inſulated maſſes; ſometimes regularly cryſtallized, and diſpoſed in veins. 5. The native ſalts of iron are very numerous. It has been found in the ſtate of ſulphate, phoſphate, carbonate, tungſtate, and pruſſiate, and there is reaſon to believe, that it exiſts in combination with many other acids.

1883 Analyſis. 3. The method of aſſaying iron ores, or of extracting the metal from theſe ſubſtances with which it is combined, varies according to the nature of the ore. It is firſt reduced into powder, and expoſed to heat, to ſeparate the moiſture or ſulphur, or other volatile matters. Four parts of the ore are then to be mixed with an equal quantity of decrepitated muriate of ſoda, and the ſame quantity of a mixture of equal parts of fluor ſpar and lime, with one-half part of charcoal. This mixture is expoſed to a red-heat in a crucible nearly an hour, after which the iron is found in the metallic ſtate at the bottom of the crucible. In the humid way, a given quantity of iron ore may be reduced to powder, and digeſted with ſix parts of muriatic acid, which combines with the iron, and other ſubſtances ſoluble in that acid, but leaves the ſulphur and ſiliceous earth behind. The ſolution is then to be ſaturated with potaſh, by which the iron is precipitated in the ſtate of oxide, along with the earths with which it had combined. The precipitate is to be well dried, and ſubjected to a red-heat. It is then to be reduced to powder, and digeſted with diluted nitric acid. The acid combines with the earths, but leaves the iron, becauſe it is too highly oxidated to be ſoluble in this acid. The oxide, after being well waſhed, is mixed with charcoal, and expoſed to a ſtrong heat in a crucible, by which the oxygen is driven off, and the iron remains behind in the metallic ſtate.

1884 Properties. 4. Iron has a peculiar metallic brilliancy. It is of a grayiſh or bluiſh-white colour. The ſpecific gravity of iron is from 7.6 to 7.89, and according to ſome, even 8.16. It has an aſtringent taſte, and when it is rubbed, gives out a peculiar ſmell. One of the ſingular properties of iron, is that of poſſeſſing the magnetic virtue, or of being attracted by the magnet. Iron poſſeſſes a conſiderable degree of malleability, but in this property it is inferior to gold or ſilver. It is extremely ductile. It may be drawn out into wire almoſt as fine as hair. The tenacity of iron is very great. A wire .078 of an inch in diameter will ſupport a weight, without breaking, equal to more than 500 lib. avoirdupois *. The texture of iron ſeems to be fibrous, and to this, it is ſuppoſed, are owing its great ductility and tenacity.

1885 Action of heat. 5. Iron is one of the moſt infuſible of the metals. It is ſaid that it requires a temperature equal to more than 150° Wedgwood for its fuſion. It becomes red long before it melts, and different degrees of temperature are diſtinguiſhed by the different ſhades of red which it exhibits. The firſt is called a *dull red*, the ſecond a *cherry red*, the third a *bright red*, and the fourth a *white heat*, or *incandeſcence*.

1886 Oxidation. 6. When iron is expoſed to the air, the ſurface ſoon becomes tarniſhed, and is covered with a brown powder, which is called *ruſt*. This proceſs is greatly promoted by the moiſture of the atmoſphere. This is the oxidation of the metal, and its converſion into an oxide, by combining with the oxygen of the atmoſphere. The proceſs of ruſting, then, is the oxidation of the iron, and it is owing to the ſtrong affinity which exiſts between iron and oxygen. But ruſt is not merely a compound of oxygen and iron. It has combined with a certain proportion of carbonic acid. This was formerly called *ſaffron of mars*.

1887 Oxides two. 7. There are two oxides of iron; the firſt, or that which contains the greateſt proportion of oxygen, is common ruſt, or, as it is denominated from its colour,

1888 Red oxide. brown or red oxide of iron. This oxide may be formed by expoſing iron filings in an open veſſel to a red heat, and agitating them till they are converted into a red powder. This oxide conſiſts of

Oxygen,	48
Iron,	52
	100

The red oxide of iron cannot be decompoſed by heat; but when it is expoſed to heat with its own weight of iron filings, there is no evolution of any gas, but the

1889 Black. iron filings are converted into a black powder, and the red oxide is converted into a ſimilar powder. This is the black oxide of iron, which contains the ſmaller proportion of oxygen. This oxide is compoſed of

Oxygen,	27
Iron,	73
	100

This oxide may alſo be obtained by heating iron filings for ſome time in water at a temperature not under 70°, or by making the vapour of water paſs through a red-hot tube containing iron wire, or ſmall fragments of iron. The water in theſe caſes is decompoſed, the hydrogen eſcapes in the form of gas, and the oxygen combines with the iron. This oxide was formerly called *martial ethiops*. It is this oxide which is obtained by burning iron wire in oxygen gas.

8. There is no action between iron and azote. Hydrogen gas, which is obtained from the decompoſition of water by means of iron filings and ſulphuric acid, holds a ſmall quantity of iron in ſolution. When hydrogen gas is brought into contact with the red oxide of iron, it deprives it of that proportion of oxygen which it contains above the black oxide, and converts it into this oxide.

1890 Carburet. 9. Iron combines very readily with carbone, and forms a carburet. When the charcoal combines with one-tenth of its weight of iron, it conſtitutes a carburet, which is found native, and diſtinguiſhed by the name of *plumbago*, or *black lead*. This compound has a metallic luſtre, is of a bluiſh or dark-gray colour, has a greaſy feel, and ſtains the fingers. It is well known as the ſubſtance of which black-lead pencils are compoſed. But there is another combination of iron with carbone, which forms one of the moſt important compounds, on account of its valuable properties, and the numerous uſes to which it is applied. This is ſteel. The different ſtates of iron are owing to its being perfectly free from contamination with other ſubſtances, or to its combination with carbone in different proportions. In theſe different ſtates it is diſtinguiſhed by the names of *caſt* or *crude iron*, *wrought iron*, and *ſteel*.

1891 Proceſs for obtaining. *Crude* or *caſt iron*.—When iron is firſt extracted from its ores, it is in the ſtate of what is called crude iron. Iron is generally obtained from ores in the ſtate of oxide, and this is frequently mixed with clay. It muſt therefore be ſeparated from theſe ſubſtances. This is accompliſhed by reducing the ore to ſmall pieces, and mixing it with a flux compoſed of limeſtone and charcoal. It is then expoſed to a very ſtrong heat. For this proceſs, furnaces are conſtructed in ſuch a way, that the heat can be raiſed to a very high temperature. The nature of the proceſs muſt be obvious. The carbone of the charcoal combines with the oxygen of the iron, and forms carbonic acid, which is driven off in the ſtate of gas. By the ſtrong heat to which the lime and the clay are ſubjected, they are fuſed together, and form a vitreous matter, which being lighter than the iron, riſes to the ſurface. The iron alſo is in a ſtate of fuſion at the bottom of the furnace. When the proceſs is finiſhed, a hole is opened, through which the fluid iron flows, and is received into moulds. This is crude or caſt iron, or, in the language of the workmen, *pig iron*. In this ſtate it is extremely brittle and hard, and poſſeſſes ſcarcely any malleability. It ſtill contains a conſiderable proportion of carbone, and it is not entirely free from oxygen.

1892 Soft iron. *Wrought Iron*.—The next proceſs in the manufacture of iron, is to deprive it of thoſe ſubſtances which alter its properties, and prevent its application to the purpoſes of pure or malleable iron. The crude iron is again introduced into a furnace, where it is melted by the flame of combuſtible ſubſtances, which is directed to its ſurface; and while it is in the ſtate of fuſion, it is conſtantly ſtirred, that the whole of it may be uniformly brought into contact with the air. At laſt it ſwells, and gives out a blue flame, and when this is continued for about an hour, the iron begins to acquire ſome conſiſtency, and at laſt becomes ſolid. While it is hot, it is removed from the furnace, and hammered by the action of machinery. It is then in the ſtate of wrought or ſoft iron.

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* Ann. de Chim. 25. 9.

Steel.—This is ſoft iron or wrought iron combined with a certain portion of carbone. There are different proceſſes for the preparation of ſteel; and the 1893 Natural ſteel. ſteel prepared by theſe proceſſes has received different names. What is called natural ſteel, is prepared by expoſing caſt iron to a ſtrong heat in a furnace, while its ſurface is covered with ſcoriæ. In this proceſs, part of the carbone of the crude iron combines with the oxygen, from which it is not entirely free, and is driven off in the ſtate of carbonic acid gas. The iron remains combined with a ſmall proportion of carbone. The ſteel prepared in this way is of an inferior quality.

1894 Of cementation. Steel of cementation is prepared by arranging bars of pure iron and charcoal in powder in alternate layers, in large troughs or crucibles, which are carefully cloſed up with clay. Theſe are expoſed to heat in a furnace for the ſpace of eight or ten days, when the bars of iron are found converted into ſteel. This is ſometimes called *bliſtered ſteel*, from bliſters which appear on the ſurface, or tilted ſteel, when it is drawn out into ſmaller bars by the hammer. By breaking it into pieces, and repeated welding in a furnace, and afterwards drawing it out into bars, it is converted into what is called *German* or *ſheer ſteel.* Steel formed in this way is generally of a ſuperior quality to natural ſteel.

1895 Caſt. *Caſt ſteel* is prepared by fuſing natural ſteel with charcoal powder, and pounded glaſs, in a cloſe crucible; or by melting together 30 parts of iron, one of pounded glaſs, and one of charcoal. By this proceſs the beſt kind of ſteel is obtained, and it is this which is generally uſed for the finer kinds of cutting inſtruments. Different opinions have been entertained concerning the proportions of iron and carbone in the compoſition of ſteel. According to ſome, the proportion of carbone amounts to $\frac{1}{12}$ part, though, according to others, it does not exceed $\frac{1}{150}$ part.

1896 Properties of ſteel. Steel poſſeſſes very different properties from iron. It is extremely hard and brittle, does not yield to the file, and retains the magnetic virtue for any length of time. When it is hammered, its ſpecific gravity is greater than that of iron. It is not malleable when cold, but it has this property when red-hot, and it may be reduced to thinner plates than iron.

1897 Diſtinguiſhed from iron. There is a very eaſy teſt by which ſteel may be diſtinguiſhed from iron. If a drop of diluted nitric acid be let fall on ſteel, and allowed to remain for a few minutes, it leaves behind, after it is waſhed off, a black ſpot, which is owing to the converſion of the carbone of the ſteel into charcoal, by combining with the oxygen of the acid. But if nitric acid is dropt on iron, a whitiſh gray ſpot remains.

1898 Phoſphuret. 10. Iron combines with phoſphorus, and forms with it a phoſphuret. It may be formed by melting in a crucible 16 parts of phoſphoric glaſs with 16 parts of iron, and one-half part of charcoal in powder. The phoſphuret of iron is of a white colour when it is broken, and it is obſerved cryſtallized in ſome points in rhomboidal priſms. It is of a ſtriated and granulated texture, and is magnetic. This phoſphuret may be formed alſo, by dropping ſmall bits of phoſphorus into iron filings heated red-hot. This is the *ſiderite* of Bergman, in which he ſuppoſed he had diſcovered a new metal, to which he gave the name of *ſiderum.* 1899 Cold ſhort iron. What is called *cold ſhort iron*, from its being brittle when cold, but malleable when it is heated, contains a certain portion of phoſphate of iron, to which this property is owing. It was in the inveſtigation of the nature of this iron, that Bergman obtained, by means of ſulphuric acid, a white powder, which was converted into a brittle metal of a dark-gray colour. By the experiments of Klaproth and Scheele it was proved, that cold ſhort iron is a compound of phoſphoric acid and iron.

1900 Sulphuret. 11. Iron combines with ſulphur by different proceſſes. A ſulphuret of iron may be prepared by fuſing together in a crucible, equal parts of powdered ſulphur and iron filings. This is a maſs which is remarkably brittle and hard, and of a deep-gray colour. If this maſs be reduced to powder, and moiſtened with water, the water is decompoſed, its oxygen combines with the ſulphur, which is converted into ſulphuric acid, and the iron is oxidated. If equal parts of ſulphur and iron-filings be well mixed together by trituration, and a ſufficient quantity of water be added, to form the whole into a paſte, and if this mixture be expoſed to the air, it ſoon becomes hot, ſwells up and cracks, exhaling the vapours of ſulphurated hydrogen gas, and ſometimes is ſpontaneouſly inflamed. During this action the water is decompoſed, the iron is oxidated, and the ſulphur is converted into ſulphuric acid, while the hydrogen of the water combines with a portion of ſulphur, and forms ſulphurated hydrogen gas. By obſerving the phenomena of this proceſs, which alſo takes place, it is ſaid, when the mixture is buried under ground, Lemery ſuppoſed that he could explain the nature and cauſe of volcanic eruptions.

If a mixture of three parts by weight of iron filings, and one of powdered ſulphur, be put into a glaſs veſſel on burning coals, a ſulphuret of iron is obtained, with ſome remarkable phenomena. It firſt melts, and then all at once becomes red-hot, and ſometimes, when the quantity is conſiderable, is accompanied with an exploſion, at the moment when the combination takes place. According to the experiments of Prouſt, the component parts of ſulphuret of iron are,

Sulphur	60
Iron	40
	100

1901 Pyrites. According to the experiments of the ſame chemiſt, pyrites, which is found in great abundance in nature, and uſually cryſtallized in cubes, is ſulphuret of iron combined with an additional portion of ſulphur. The component parts of pyrites are

Sulphuret of iron	80
Sulphur	20
	100

12. Iron enters into combination with the acids, and forms ſalts, and with the metals, and forms alloys.

1902 Affinities. The affinities of iron and its oxides are, according to Bergman, in the following order.

Iron.	Oxide of Iron.
Nickel,	Oxalic acid,
Cobalt,	Tartaric,
Manganeſe,	Camphoric,
Arſenic,	Sulphuric,
Copper,	Saclactic,
Gold,	Muriatic,
Silver,	Nitric,
Tin,	Phoſphoric,
Antimony,	Arſenic,
Platina,	Fluoric,
Biſmuth,	Succinic,
Lead,	Citric,
Mercury.	Lactic,
	Acetic,
	Boracic,
	Pruſſic,
	Carbonic.

I. Salts of Iron.

1. Sulphate of Iron.

1903 Preparation. 1. Concentrated ſulphuric acid has ſcarcely any action on iron. When it is heated, the acid is decompoſed, part of its oxygen combines with the iron, and ſulphurous acid gas is evolved. But when diluted ſulphuric acid is added to iron filings, a violent efferveſcence takes place, and hydrogen gas is diſengaged. In this proceſs, the water, with which the acid is diluted, is decompoſed, the oxygen of which combines with the iron, and converts it into an oxide, while the hydrogen eſcapes in the ſtate of gas. 1904 Properties. The ſolution is of a green colour, and, by evaporation, it affords cryſtals of ſulphate of iron, which are tranſparent, of a fine green colour, in the form of rhomboidal priſms, and having an acrid aſtringent taſte. This ſalt almoſt always reddens vegetable blues. It is very ſoluble; two parts of cold water, and leſs than its weight of boiling water, are ſufficient for its ſolution.

1905 Found native. 2. This ſalt is, in many places of the world, a natural production. It is obtained from the decompoſition of pyrites, which it is ſometimes found neceſſary to promote by art. 1906 Manufacture. This is done by throwing them together into heaps, and watering them occaſionally. Sometimes previous roaſting is neceſſary, either to render them more brittle, and to ſeparate the additional portion of ſulphur above what is neceſſary to conſtitute a ſulphuret. After a certain time an effloreſcence takes place, and the ſurface is covered with the ſulphate of iron, which is diſſolved in water, concentrated by boiling, and evaporated, and then allowed to cool and cryſtallize. 1907 Names. This ſalt, which was known to the ancients, was denominated *miſy*, *ſory*, and *calchantum*. It is diſtinguiſhed in commerce by a great variety of names, as *martial vitriol*, *roman vitriol*, and moſt commonly by the names of *green copperas*, or *green vitriol*.

1908 Action of heat. 3. When ſulphate of iron is ſtrongly heated, it melts, and is deprived of its water of cryſtallization. Sulphurous acid gas is then given out, it aſſumes a red colour, and is reduced to the ſtate of powder. This was formerly called *colcothar*, and *colcothar of vitriol*. It is the ſalt almoſt entirely decompoſed. Part of the iron is ſtrongly oxidated, and to this the red colour is owing. It is alſo mixed with ſulphate of iron; but the iron in this caſe is alſo converted into the red oxide, with the greater proportion of oxygen. This change, it is obvious, depends on the ſtrong affinity of iron for oxygen; for, by the action of heat, the ſulphate of iron of which the green oxide forms the baſe, is decompoſed; the oxygen of the acid combines with the iron, and converts it into the red oxide; part of which, as it is formed, unites with the acid, before the whole of it is decompoſed; and in this way the product of this proceſs is the red oxide of iron mixed with red ſulphate.

1909 Compoſition. The component parts of this ſalt are, according to Bergman,

Acid,	39
Oxide,	23
Water,	38
	100

Theſe properties vary, according to the eſtimation of Mr Kirwan, who makes this ſalt to be compoſed of

Acid,	26
Oxide,	28
Water of compoſition,	8
of cryſtallization,	38
	100

This diſtinction made by Mr Kirwan between the water of compoſition and that of cryſtallization is, that the former is combined with the oxide, and the latter with the ſalt.

1910 Action of air. 4. When this ſalt is expoſed to the air, it becomes of a yellowiſh colour, opaque, and a powder forms on the ſurface. The ſame thing takes place, if the ſalt in ſolution in water be expoſed to the air. From a fine tranſparent green colour, it becomes turbid, and is converted into a yellowiſh-red liquid, and there is precipitated a powder of the ſame colour. This change is owing to the abſorption of oxygen, and the converſion of the green oxide with the ſmaller proportion of oxygen, into the red oxide with the greater proportion. This proceſs is greatly promoted by the direct combination of oxygen, or by the addition of thoſe ſubſtances which are readily decompoſed, and give out their oxygen. When oxymuriatic acid is added to the ſolution, it becomes inſtantly yellow, and there is formed a red precipitate. The ſame change takes place when the ſalt is diſſolved in water impregnated with carbonic acid. The iron decompoſes the acid, and combines with its oxygen. Thus it appears, that the decompoſition of the ſulphate of iron is owing, in all theſe caſes, to the abſorption of oxygen, and to the higher degree of oxidation of the metal.

1911 Decompoſition. 5. The ſulphate of iron is converted into the red ſulphate by means of nitric acid. It is decompoſed by the alkaline earths and the alkalies, which precipitate it in the form of oxide. The pure fixed alkalies and lime ſeparate an oxide of a deep green colour, which, being expoſed to the air, is converted into the red oxide. Ammonia affords a precipitate of a deeper green colour. The ſulphurets and hydroſulphurets precipitate from the ſolution of green ſulphate of iron, a black ſulphurated or hydroſulphurated oxide. Moſt of the ſalts decompoſe the ſulphate of iron. When equal parts of nitrate of potaſh and ſulphate of iron are diſtilled together in a retort, a weak nitric acid at firſt paſſes over, then a nitrous acid, and at laſt a very ſmall quantity of ſulphurous acid. The muriate of ſoda is decompoſed by the ſulphate of iron, in conſequence of the diſengagement of ſulphuric acid, which ſeparates the muriatic acid from its baſe. Sulphate of ſoda, combined with the oxide of iron in the ſtate of a vitreous maſs, remains in the retort. The hyperoxymuriate of potaſh converts the green ſulphate of iron into the red. This ſalt is alſo decompoſed by the alkaline phoſphates, borates, and carbonates.

1912 Preparation. *Red ſulphate of iron.*—In the detail which has been given of the properties of the green ſulphate of iron, it appears, that it has a ſtrong affinity for oxygen. The oxide of the green ſulphate contains 27 parts of oxygen; but by abſorbing another portion of oxygen, it is converted into the red oxide, which contains 48 parts of oxygen. This ſalt may be obtained by the direct combination of the red oxide of iron with concentrated ſulphuric acid, with the aſſiſtance of heat. The ſalt remains in the ſolution from which the green ſulphate of iron has been cryſtallized. This ſolution has been called the *mother water of vitriol*. The red ſulphate of iron is very different in its properties from the green ſulphate. It does not afford cryſtals; it is diſtinguiſhed by its red colour, and it depoſits the oxide 1913 Properties. of iron, when brought in contact with the air, or by the action of heat. It deliqueſces in the air, and at laſt becomes liquid. It is more ſoluble in water than the green ſulphate; and alſo ſoluble in alcohol, by which it may be ſeparated from the green ſulphate, which is not affected by the alcohol. When iron filings are added to a ſolution of red ſulphate of iron, part of the oxide is ſeparated, another part gives up a portion of its oxygen to the iron, and is converted into the green ſulphate. The ſame effect is produced, as M. Prouſt, by whom this ſubject has been greatly elucidated, obſerves, by means of other metals, as mercury, zinc, and tin. The two ſulphates of iron are diſtinguiſhed by other properties. The infuſion of nut-galls produces no change in the green ſulphate of iron, but gives a fine black precipitate with the red ſulphate.

1914 Action of pruſſiate of potaſh. Pruſſiate of potaſh occaſions no change of colour on the green ſulphate of iron, but produces a deep blue precipitate with the red ſulphate, from which it appears that there are two pruſſiates of iron, correſponding to the two oxides. The white pruſſiate contains the green oxide with the ſmaller proportion of oxygen; the blue pruſſiate, the red oxide with the greater proportion. Another characteriſtic property is, that the green ſulphate of iron abſorbs nitrous gas in conſiderable quantity, and aſſumes a yellowiſh colour; but no ſuch abſorption is effected by the red ſulphate.

2. Sulphite of Iron.

1915 Preparation. 1. Sulphurous acid is decompoſed by iron, and the portion of ſulphur which is ſeparated, remains in combination with the ſalt as it is formed. When liquid ſulphurous acid is added to iron filings, it aſſumes a deep yellow colour; ſome hydrogen gas is evolved, with a production of heat, and the yellow colour ſoon changes to a greeniſh ſhade. Sulphuric or muriatic acid, added to this ſolution, produces an efferveſcence, but without any precipitation. It is neceſſary to add the acid in conſiderable quantity to obtain a precipitate of ſulphur in white powder. Fuming nitrous acid ſeparates the ſulphur of a yellow colour, and in the form of a ductile maſs. From theſe facts it appears, that the firſt portion of acids acts only on the ſimple ſulphite of iron; but when a greater quantity is added, the ſulphurated ſulphite is decompoſed, and the ſulphur is depoſited.

1916 Properties. 2. The ſolution of iron in ſulphurous acid, expoſed to the air, depoſits a reddiſh-yellow powder, and affords cryſtals which are ſurrounded with this reddiſh powder. By adding water to this maſs, it diſſolves the cryſtallized part, and leaves the red powder, which being diſſolved in muriatic acid, gives up its iron, and depoſits ſulphur, which is ſtill mixed with a little iron. 1917 Sulphurated ſulphite. This precipitate diſſolved in water, affords a ſulphurated ſulphite of iron, with a ſmaller quantity of ſulphur than the firſt ſolution. Expoſed to the air after the firſt precipitate is formed, the ſurface is ſoon covered with a red pellicle. A red powder is depoſited, and afterwards cryſtals of ſulphite of iron.

1918 Properties. 3. The ſulphurated ſulphite of iron remains permanent by expoſure to the air. Its ſimple ſulphite abſorbs oxygen. The ſulphurated ſulphite depoſits ſulphur by the action of the acids. The ſulphite gives out ſulphurous acid. The ſulphurated ſulphite is ſoluble in alcohol; the ſulphite is inſoluble.

4. The red ſulphate of iron with the greater proportion of oxygen, does not produce the ſame effect on ſulphurous acid, by converting it into ſulphuric acid, and thus to form a ſulphate of iron, as the oxide of manganeſe, becauſe iron has a ſtronger affinity for oxygen 1919 Strong affinity of iron for oxygen. than ſulphurous acid. Thus we have ſeen, in conſequence of the ſame affinity of iron for oxygen, that it decompoſes ſulphuric acid, and converts part of it into ſulphurous acid, and that it even decompoſes ſulphurous acid, by ſeparating its ſulphur, which combines with the oxide as it is formed, and conſtitutes the ſulphurated ſulphite of iron. Neither of theſe ſulphites of iron give a black colour with the infuſion of nut galls, nor a blue colour with the pruſſiate of potaſh; from which it is inferred that the iron is in its minimum ſtate of oxidation, or in that of a green ſulphate of iron.

3. Nitrate of Iron.

1920 Preparation. Nitric acid acts with great violence on iron; a great quantity of nitrous gas is diſengaged, eſpecially when the acid is a little diluted with water. When diluted 1921 Properties. acid has been employed, the ſolution is of a yellowiſh green colour, and when it is expoſed to the air, it aſſumes a pale colour, in conſequence of the nitrous gas which it holds in ſolution, combining with oxygen, and being converted into nitric acid. When it is expoſed to the air, or concentrated by evaporation, a precipitate of the red oxide of iron is formed, becauſe it combines with another portion of oxygen, and is converted from the green to the red oxide. By means of the alkalies, the green oxide is precipitated from this ſolution.

1922 Preparation. *Red nitrate of iron.*—This is the ſalt formed with nitric acid and the red oxide of iron. It is prepared by expoſing the green nitrate of iron to the air, which abſorbing oxygen, is converted into the red nitrate.

If iron be diſſolved in concentrated nitric acid, the iron is converted into the red oxide, and this combining 1923 Properties. with the undecompoſed acid, alſo forms the red nitrate of iron. The ſolution of this ſalt, which is of a brown colour, does not cryſtallize; when it is evaporated, it aſſumes the form of jelly, or depoſits a red powder. 1924 Action of nut galls, &c. When this ſalt is heated, the acid is driven off, and the red oxide remains behind. The red nitrate of iron gives a black colour with the infuſion of galls, and a blue precipitate with pruſſiate of potaſh, from which it appears, that the iron is in its higheſt degree of oxidation. This has been fully demonſtrated by an experiment made by Vauquelin. Concentrated nitric acid was kept for ſome months on black oxide of iron, without any apparent change. The nitric acid, however, loſt its acidity, and acquired a neutral taſte. The liquid had aſſumed a brown colour, and large cryſtals, tranſparent and white, with a ſlight tinge of violet by looking through them, were formed. The cryſtals were in ſquare priſms, terminated by two-ſided ridges. This ſalt was extremely deliqueſcent, and had a pungent inky taſte. The ſolution in water becomes red, as is alſo the precipitate, by means of ammonia and potaſh. Pruſſiate of potaſh gives a fine blue precipitate.

4. Muriate of Iron.

1925 Action of muriatic acid in the ſtate of gas. 1. When iron filings are expoſed to muriatic acid gas they ſoon become black, and are converted into the ſtate of red oxide. This is owing to the decompoſition of the water which the gas holds in ſolution. The bulk of the gas is increaſed by the addition of hydrogen gas, from this decompoſition of water. When the whole of the muriatic acid is abſorbed by the iron in the ſtate of oxide, hydrogen gas only remains in the veſſel in which the proceſs has been conducted. When a little water is added, it aſſumes a green colour, having combined with the muriate of iron in the liquid ſtate.

1926 In the liquid ſtate. 2. Liquid muriatic acid acts upon iron in proportion to its degree of concentration, and the action is the more violent as it is leſs concentrated. An efferveſcence takes place, with the diſengagement of hydrogen gas. As the iron is oxidated by the decompoſition of the water, it is diſſolved in the acid. This ſolution is of a pale yellowiſh colour, and of a ſtrong ſtyptic taſte. When it is evaporated to the conſiſtence of ſyrup, it forms, on cooling, a viſcid maſs, in which are found needle-ſhaped, deliqueſcent cryſtals. When this ſolution is expoſed to the air, or ſtrongly heated, it aſſumes a brown colour, and depoſits oxide of iron.

Red muriate of iron.—When the red oxide of iron is treated with muriatic acid, the acid diſſolves the iron, and forms a ſolution of a deep brown colour. During the ſolution, oxymuriatic acid is formed and given out, which is owing to the combination of a portion of the oxygen of the oxide with the muriatic acid. The oxide thus deprived of a portion of its oxygen, combines with the muriatic acid, and forms red muriate of iron. When this ſolution is evaporated to dryneſs, it affords a yellow-coloured maſs, which is deliqueſcent in the air. This ſalt does not abſorb nitrous gas, and it is converted into muriate of iron by the action of ſulphurated hydrogen gas. When it is precipitated by the alkalies, the oxide is not farther changed by expoſure to the air. The infuſion of nut galls gives a black colour, and the pruſſiate of potaſh a blue.

5. Hyperoxymuriate of Iron.

This ſalt was formed by Mr Chenevix, by directing a ſtream of oxymuriatic acid gas into water, having red oxide of iron diffuſed in it; but its properties have not been aſcertained.

6. Fluate of Iron.

Fluoric acid has a very powerful action on iron, which is owing to the evolution of hydrogen gas, and the decompoſition of water. The iron is oxidated, and diſſolves in the acid, forming a fluate of iron. The ſolution has a ſtyptic, metallic taſte, does not afford cryſtals by evaporation, but aſſumes a gelatinous form. Evaporated to dryneſs, it becomes hard and ſolid; and when ſtrongly heated, the acid is driven off, and there remains behind the red oxide of iron, ſo that this ſalt is the red fluate of iron. The red oxide of iron is alſo ſoluble in fluoric acid, and communicates to it, according to Scheele, an aluminous taſte. The fluate of iron is decompoſed by ſulphuric acid, and is precipitated by the alkalies and the earths.

7. Borate of Iron.

Boracic acid promotes the oxidation of iron by water very ſlowly. The borate of iron may be obtained by precipitating the ſulphate of iron by means of the borate of ſoda, or borax. The borate of ſoda is precipitated in the form of a whitiſh powder. It is inſoluble in water, but its other properties have not been aſcertained.

8. Phoſphate of Iron.

Phoſphoric acid combines very ſlowly with iron, 1927 Preparation. but after the oxidation of the metal has taken place, it forms with its oxide an inſoluble ſalt. The phoſphate of iron may be prepared by adding a ſolution of an alkaline phoſphate to a ſolution of ſulphate or nitrate of iron. The alkali leaves the phoſphoric acid, and combines with the ſulphuric or nitric; while the phoſphoric acid combines with the iron, and forms a phoſphate of iron, which is in the ſtate of white precipitate. Phoſphoric acid combines with both oxides of iron, and conſtitutes either a green or a red phoſphate. The red phoſphate of iron may be obtained by precipitating the red muriate of iron in ſolution, by means of phoſphate of potaſh or ſoda; and when this latter ſalt is treated with pure fixed alkalies, a browniſh red powder is precipitated, which is the red phoſphate of iron with exceſs of baſe. It is nearly inſoluble in acids and in water, but is ſoluble in the ſerum of blood and the white of an egg, communicating to 1928 Colours the blood. them a brown colour. This ſalt exiſts in the blood of animals, and to it the red colour of the blood is owing.

9. Carbonate of Iron.

Carbonic acid combines readily with the oxide of iron. This is the caſe when iron ruſts in the air; for in proportion as the oxidation of the iron is effected, it combines with the carbonic acid of the atmoſphere, and forms a carbonate of iron. This acid diſſolved in water, when brought in contact with iron, acts upon it ſlowly; and there is diſengaged, but without efferveſcence, a perceptible odour of hydrogen gas, and the water acquires in the courſe of a few hours, an aſtringent taſte. When this ſolution is expoſed to the air, as Bergman obſerved, it becomes covered with an irideſcent pellicle, and is decompoſed by lime and the alkalies. But the alkaline carbonates have no ſuch effect. This ſolution of the carbonate of iron converts the ſyrup of violets to a green colour. When it is evaporated, it depoſits the ſalt in the form of a reddiſh ochre. It is this carbonate of iron which exiſts in mineral waters, to which, for this reaſon, the name of *chalybeate* has been given to waters. 1929 Ruſt. Ruſt is a carbonate of iron, mixed with the oxide. Fourcroy found by diſtilling it, that it yielded carbonic acid gas, and a little water, and there remained black oxide of iron; and diſtilled with muriate of ammonia, it afforded carbonate of ammonia. The component parts of this carbonate, according to Bergman, are

Acid,	24
Oxide,	76
	100

10. Arſeniate of Iron.

1930 Preparation. 1. When iron is digeſted with arſenic acid, it is diſſolved, and towards the end of the proceſs the ſolution aſſumes the form of a jelly. But if it be conducted in a cloſe veſſel, no coagulation takes place. By expoſing it to the open air for ſome hours, the ſurface becomes ſo ſolid, that the veſſel may be inverted without any part of it dropping out. The ſolution which has not been expoſed to the air, affords a precipitate with potaſh, of a greeniſh-gray colour, from which there is diſengaged by heat, arſenious acid, and there remains behind a red oxide of iron. One part of iron-filings diſtilled with four of concrete arſenic acid, ſwell up and inflame; the metallic acid is ſublimed, and brown ſpots appear on the ſides of the retort. From this experiment it appears, that the iron has carried off the oxygen from the acid.

2. Arſenic acid does not precipitate iron from its ſolutions, but the arſeniates or arſenites form a very ſoluble precipitate, which becomes yellow or red in contact with the air. This precipitate, which is fuſible at a high temperature, exhales the odour of arſenic when it is melted, is converted into black ſcoriæ when it is treated with charcoal, gives out a conſiderable quantity of arſenic, and is reduced to the ſtate of black oxide of iron.

1931 Green arſeniate. 3. Arſenic acid combines with both the oxides of iron. The green arſeniate of iron may be obtained by adding a ſolution of arſeniate of ammonia to a ſolution of ſulphite of iron. The arſeniate precipitates in the form of powder which is inſoluble in water. The component parts of this ſalt, according to Chenevix, are

Acid,	38
Oxide,	43
Water,	19
	100

Red Arſeniate of Iron.—This ſalt is prepared, either by boiling arſeniate of iron in nitric acid, or by adding arſeniate of ammonia to a ſolution of red ſulphate of iron. It is compoſed of

Acid,	42.4
Oxide,	37.2
Water,	20.4
	100.0

Both theſe ſalts have been found native.

11. Tungſtate of Iron.

Tungſtic acid has no great effect on iron in the cold. Iron immerſed in a ſolution of this acid in muriatic acid, communicates to it a beautiful blue colour, which is owing to the decompoſition of the tungſtic acid, and to its reduction to the metallic ſtate by means of the iron. Tungſtic acid precipitates from the ſolution of iron in ſulphuric acid, tungſtate of iron. Tungſtate of iron exiſts native under the name of wolfram.

12. Molybdate of Iron.

The alkaline molybdates which are ſoluble, precipitate iron from its ſolution in acids, of a brown colour.

13. Chromate of Iron.

If chromic acid, combined with an alkali, be added to a ſolution of the red ſulphate of iron, a precipitate is immediately formed, of a brown colour; but if an alkaline chromate be added to the green ſulphate of iron, the precipitate is green, becauſe the chromic acid is deprived of a portion of its oxygen, and is converted to the ſtate of green oxide *.

14. Columbate of Iron.

The columbate of iron is found native, and from the only ſpecimen which has yet been diſcovered, Mr Hatchet extracted a new metal, which has been deſcribed under the name of columbium. It is of a dark-browniſh gray colour, has a vitreous luſtre, and a lamellated ſtructure. According to Mr Hatchet, it is compoſed of

Columbic acid,	77.5
Oxide of iron,	21.0
	98.5

15. Acetate of Iron.

1932 Preparation. 1. Acetic acid diſſolves iron with efferveſcence, with the evolution of hydrogen gas. The liquid aſſumes a reddiſh-brown colour, and by evaporation becomes a gelatinous maſs, in which are found long brown cryſtals. This ſalt has a ſweetiſh ſtyptic taſte. It is decompoſed by heat, and is deliqueſcent in the air. When it is heated till it no longer gives out the odour of vinegar, it lets fall a yellowiſh oxide, which is eaſily reduced, and is attracted by the magnet. The alkalies ſeparate the iron nearly in the ſtate of black oxide. This ſolution affords a black precipitate with the infuſion of nut-galls, and a blue with the alkaline pruſſiates.

2. The

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* Fourcroy Connaiſs. Chim. vi. p. 217.

1933 In the large way.

2. The ſolution of this ſalt is prepared in the large way with old iron, and vinegar obtained from grain or molaſſes. They are expoſed to the air in large veſſels, and as the fermentation of the liquid goes on, it is converted into acetic acid, the iron is oxidated, and diſſolved by the acid. This ſolution is employed in dyeing and calico-printing.

Green acetate of iron.—This ſalt has been formed by diſſolving ſulphuret of iron in acetic acid. It affords cryſtals by evaporation, in the form of priſms, and of a green colour. The taſte is ſtyptic and ſweetiſh. It gives a white precipitate with the alkaline pruſſiates, and no change is effected by the infuſion of galls. When the ſolution of this ſalt is expoſed to the air, it very readily abſorbs oxygen, and is converted into red acetate of iron *.

18. Oxalate of Iron.

1934 Preparation.

Oxalic acid produces a violent action on iron, with the evolution of hydrogen gas. This ſolution has a very ſtyptic taſte, and forms by evaporation priſmatic cryſtals of a greeniſh yellow colour. When this ſolution is expoſed to the air, or when it is heated, it aſſumes a red colour, which is owing to the abſorption of oxygen, and its converſion into red oxalate. The oxalate of iron is compoſed of

1935 Compoſition.

Acid,	55
Oxide,	45
	100

Red oxalate of iron.—Oxalic acid precipitates the red oxide of iron from its ſolution in ſulphuric acid, and forms an oxalate of iron of a fine red colour. The red oxalate of iron does not cryſtallize, and has little ſolubility in water. This has been propoſed to be employed as a pigment. None of the acids diſſolve the oxides of iron more readily than oxalic acid, and eſpecially the gallate of iron. On this account it anſwers well for removing ſpots of ink, for which purpoſe alſo the acidulous oxalate of potaſh, or ſalt of ſorrel, is alſo employed.

17. Tartrate of Iron.

1. Tartaric acid diſſolves iron with efferveſcence, and the evolution of hydrogen gas. The ſolution becomes of a red colour, and aſſumes the form of a gelatinous maſs, but does not cryſtallize. This is the red tartrate of iron.

2. But when tartaric acid is added to the ſolution of ſulphate of iron, and heat applied, a precipitate is formed, which is not very ſoluble, but affords lamellated cryſtals. This is the compound of tartaric acid with the green oxide of iron, for it does not form a precipitate with the alkaline pruſſiates, without the addition of nitric acid.

18. Tartrate of Potaſh and Iron.

This triple ſalt, which was formerly called *chalybeated tartar*, and *tartariſed tincture of Mars*, is prepared by forming into a paſte with water, ſix parts of iron filings with 16 of tartar in powder. The mixture is left at reſt for 24 hours; and being diluted with 192 parts of water, is boiled for two hours, when cryſtals are depoſited of tartrate of potaſh and iron.

19. Citrate of Iron.

Citric acid acts upon iron with efferveſcence, occaſioned by the emiſſion of hydrogen gas. The ſolution becomes of a brown colour; it depoſits, by ſpontaneous evaporation, ſmall cryſtals of citrate of iron. By evaporating with heat, it becomes black as ink, and ductile while it is hot, but falls to powder, and becomes very black when it is cold. This ſalt has a very aſtringent taſte, and is very ſoluble in water. It is compoſed of

Acid,	69.62
Oxide,	30.38
	100.00

The cryſtals which were obtained by ſpontaneous evaporation, were probably the green citrate; and the black maſs by the action of heat, is probably converted into the red citrate of iron.

20. Malate of Iron.

Malic acid gives a brown ſolution by its action on iron, but it does not cryſtallize.

21. Gallate of Iron.

1936 Gallic acid gives a black colour only with the red oxide.

It has frequently been mentioned, in deſcribing the ſalts of iron, that the infuſion of nut-galls, or gallic acid, produces no precipitate or change of colour, when it is added to ſalts of iron in ſolution, of which the black or green oxide conſtitutes the baſe; but when the acid is added to a ſolution of a ſalt of iron, having the red oxide for its baſe, a black precipitate is immediately formed. From this it appears, that the black precipitate can only be obtained from the red oxide of iron, or it is the gallate of iron in the higheſt degree of oxidation. Writing ink is a compound of the ſolution of gallate of iron and the tanning principle. The important qualities of good ink are, that it ſhall be durable, and have a black colour. On this ſubject Profeſſor Robiſon obſerves, in his Notes on Dr Black's Lectures, that "the great art in ink-making is to have a ſuperabundance of aſtringent matter to counteract the diſpoſition of the iron to a farther calcination, which renders the ink brown. It would be a great improvement in the manufacture of writing paper, if ſome aſtringent matter could be introduced. A little ardent ſpirits effectually prevents the ſpoiling of ink by keeping, but makes it ſink and ſpread.

1937 Ink.

A good Proportion for Writing-Ink.

Raſped logwood, 10 ounces;
Beſt gall-nuts in coarſe powder, 3 ounces;
Gum arabic in powder, 2 ounces;
Green vitriol, 1 ounce;
Rain water, 2 quarts;
Cloves in coarſe powder, 1 drachm.

Boil the water with the logwood and gum to one half; ſtrain the hot decoction into a glazed veſſel; add the galls and cloves; mix and cover it up. When nearly cold, add the green vitriol, and ſtir it repeatedly. After ſome days, decant or ſtrain the ink into a bottle, to be kept cloſe corked in a dark place *.

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* Jour. Roy. Inſtit. i. p. 308.

* Black's Lect. v. ii. p. 481.

1938 Reaſon of the pale colour. Ink is ſometimes of a very pale colour when firſt uſed, but becomes black by expoſure to the air. This is owing to the abſorption of oxygen. The green vitriol or ſulphate of iron, which is employed in making ink, has not its baſe fully ſaturated with oxygen, or is not in the ſtate of red oxide. It is the converſion of the green into the red oxide, which takes place when it is expoſed to the air. The uſe of gum in the compoſition of ink is to prevent the precipitation of the black particles, and alſo, it is ſuppoſed, to act as a varniſh, to defend it from the air, which might give it a brown colour by farther oxidation.

22. Benzoate of Iron.

Benzoic acid readily diſſolves the oxide of iron, and forms with it yellowiſh cryſtals, which are ſweet to the taſte, effloreſce in the air, and are ſoluble in water and in alcohol. Gallic acid produces a black precipitate, and the pruſſiates give a blue. It is decompoſed by the alkalies, and by the carbonates of lime and barytes. The acid is driven off by heat *.

23. Succinate of Iron.

Succinic acid combines with the oxide of iron; and the ſolution, by evaporation, affords ſmall radiated cryſtals, which are tranſparent and of a brown colour. This ſalt is inſoluble in water. It may be formed by adding an alkaline ſuccinate to the ſolutions of iron in acids.

24. Suberate of Iron.

Suberic acid decompoſes the ſulphate of iron, and produces a deep yellow colour †.

25. Mellate of Iron.

Mellitic acid produces a copious precipitate of an Iſabella-yellow colour, in the ſolution of iron in nitric acid. This precipitate is readily diſſolved in muriatic acid ‡.

26. Lactate of Iron.

Lactic acid combines with iron, and forms with it a ſalt which does not cryſtallize. The ſolution is of a brown colour.

27. Pruſſiate of Iron.

1. Pruſſic acid combines with both the oxides of iron. When the pruſſiate of potaſh is added to a ſolution of the green ſulphate or muriate of iron, a white precipitate is obtained. This ſhews, as has been already obſerved, that the baſe of theſe ſalts is in its loweſt degree of oxidation. It is in the ſtate of green or black oxide. But if the pruſſiate of potaſh be poured into a ſolution of the red ſulphate of iron, a fine blue precipitate is formed, which is Pruſſian blue, or a pruſſiate of iron in the ſtate of red oxide.

1939 Pruſſian blue. 2. When the white precipitate of iron is expoſed to the air, it gradually abſorbs oxygen, and is converted into the blue pruſſiate, or Pruſſian blue. On the other hand, the blue pruſſiate may be converted into the white, by preſerving it in a cloſe veſſel, with plates of iron or tin. The metallic ſubſtance deprives the iron of part of its oxygen, and makes it paſs to the ſtate of green oxide; in which ſtate, combined with pruſſic acid, it is colourleſs. Sulphurated hydrogen gas produces a ſimilar effect, by depriving the iron of its oxygen. Nitric and oxymuriatic acids convert the white pruſſiate into blue, by giving up their oxygen, which combines with the iron, and forms the red oxide.

II. Action of the Alkalies, &c. on Iron.

1940 Alkalies. 1. Iron, in the metallic ſtate, has a very feeble action on the alkalies and earths. The alkalies, in their pure and concentrated ſtate, promote the decompoſition of water by means of iron. Hydrogen gas is diſengaged, and the metal is converted into the ſtate of black oxide, or *martial ethiops;* but there ſeems to be no perceptible ſolution of the oxide of iron, which is thus formed in the liquid alkalies.

1941 Earths. 2. The brown oxides of iron readily combine with the earths ſuſpended in water. This combination has been long employed on account of its properties of aſſuming a great degree of ſolidity and hardneſs, as a cement, and eſpecially as a cement or mortar to be employed under water. Hence volcanic productions, as *pouzzolana earths*, which contain a conſiderable proportion of oxide of iron, are often employed for this purpoſe. The oxide of iron combines alſo with the earths by means of fuſion, and communicates to them various ſhades of colour, according to the degree of oxidation, and the proportion of oxide employed. In this ſtate it is uſed in the fabrication of enamels and coloured glaſs.

1942 Sulphates. 3. The alkaline ſulphates are decompoſed by iron at a high temperature. The iron deprives the ſulphuric acid of its oxygen, and reduces it to the ſtate of ſulphur. Fourcroy heated for an hour in a covered crucible, one part of ſulphate of potaſh, with two of iron filings. He obtained a kind of granulated ſcoria, which had ſwelled up, and was of a deep green on the ſurface. It was extremely hard, and exhibited in ſome of the internal cavities, ſhining ſix-ſided plates of black oxide of iron. It had a hot, acrid taſte. When reduced to powder, it exhaled the fetid odour of ſulphurated hydrogen gas. It was not deliqueſcent in the air; and diluted with 10 parts of water, it was of a deep green colour. This was a ſolution of hydroſulphuret of potaſh, holding a ſmall quantity of iron in ſolution. Sulphur was precipitated by the addition of acids, with the evolution of ſulphurated hydrogen gas.

1943 Nitrates. 4. The nitrates are alſo decompoſed by means of iron heated to redneſs. Two or three parts of nitre, with one of clean iron filings, well triturated together, and projected into a red-hot crucible, give out at each projection a great number of vivid ſparks. After the detonation, a half fuſed maſs remains, of a reddiſh yellow colour, which, by waſhing with water, affords pure potaſh, and there remains an oxide of iron in its higheſt degree of oxidation. Steel alſo detonates with nitre, and gives out a very brilliant red flame. Theſe mixtures are employed in artificial fireworks.

1944 Muriates. 5. Some of the muriates are alſo decompoſed by iron. The experiment of Scheele in which the muriate of ſoda was decompoſed by means of iron, has already been mentioned. The muriate of ammonia is readily decompoſed by iron with the aſſiſtance of heat. Hydrogen and ammoniacal gaſes are diſengaged. A preparation formerly known by the name of *martial*

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* *Ann. de Chim.* ix. p. 316.

† *Ibid.* xxiii. p. 48.

‡ *Klaproth, Eſſays*, ii. p. 102. *Tranſl.*

ammoniacal flowers, was made with 16 parts of muriate of ammonia and one of iron filings. This mixture is ſublimed in two earthen veſſels, the one being inverted over the other. A ſmall quantity of the muriate of ammonia only is decompoſed, and the ſalt aſſumes a yellowiſh colour, with a ſmall portion of muriate of iron. The muriate of ammonia is alſo decompoſed by triturating the red oxide of iron with this ſalt. Ammonia is diſengaged, and the oxide combines with the acid.

6. Hyperoxymuriate of potaſh produces a violent detonation with iron. Two parts of this ſalt with one of iron filings, detonate ſtrongly, and with a vivid red flame, by percuſſion, or even by ſudden preſſure, or by being brought in contact with a burning body.

7. There is no action between the fluates, borates, phoſphates, or the carbonates, and iron, in the cold.

III. Alloys.

1945 Arſenic. 1. Iron combines with arſenic by fuſion, forming a brittle alloy of a white colour, analogous to the native compound of arſenic and iron, known by the name of *miſpickel*. It is more fuſible than iron, and is therefore employed, on account of its luſtre and fine poliſh, for different purpoſes to which iron is not applicable.

1946 Tungſten. 2. The alloys of iron with tungſten, molybdena, chromium, columbium, titanium, and uranium, are ſcarcely known. With titanium iron affords an alloy of a gray colour, which is extremely infuſible.

1947 Cobalt. 3. The alloy of iron and cobalt poſſeſſes ſome of the properties of ſteel. It is extremely hard, its texture is fine-grained, and it is attracted by the magnet.

1948 Nickel. 4. Iron combines with nickel, and the affinity between theſe metals is ſo ſtrong, that it is extremely difficult to deprive nickel entirely of iron.

1949 Manganeſe. 5. Manganeſe is frequently found in combination with iron, to which it communicates a white colour, and renders it brittle.

1950 Biſmuth. 6. Biſmuth forms a brittle alloy with iron. It is attracted by the magnet, even when the proportion of biſmuth amounts to three-fourths of the whole. Twenty parts of iron and one of biſmuth, were broken by a weight of 151lb. but four parts of iron and three of biſmuth only ſupported 35lb. Theſe were the experiments of Muſchenbroeck. Gellert has obſerved, that the alloy of iron and biſmuth has an inferior ſpecific gravity to the mean.

1951 Antimony. 7. Iron combines readily with antimony by fuſion. An alloy of equal parts of theſe metals is not attracted by the magnet, has no ductility, and ſcarcely any malleability. This alloy was formerly called *martial regulus*. It is brittle and hard, and has a leſs ſpecific gravity than the mean. Iron has a ſtronger affinity for ſulphur than for antimony, for when the ſulphuret of antimony is heated with iron, it is decompoſed, and the iron combines with the ſulphur.

1952 Mercury. 8. Iron, it has been long ſuppoſed, has no action on mercury; but by triturating together the amalgam of zinc and mercury with iron filings, and by adding to the mixture a ſolution of iron in muriatic acid, and afterwards by kneading this mixture and heating it, Mr Aikin obtained an amalgam of iron and mercury, having the metallic luſtre *.

1953 Zinc. 9. Zinc forms an alloy with iron, but combines with it in very ſmall proportion. It has been obſerved that zinc may be applied to the ſurface of iron by fuſion, ſo as to defend it from the action of the air, and thus to prevent it from ruſting.

1954 Tin. 10. Iron combines with difficulty with tin. Bergman made a number of experiments on the alloy of iron and tin. He put a quantity of tin into a crucible, and covered it with iron filings. The crucible was then filled with charcoal, and cloſely covered. He expoſed the apparatus to the heat of a forge for half an hour, and he always obtained two diſtinct alloys, correſponding to the weight of the metals which he had employed.

The one was iron combined with a ſmall quantity of tin, and the other tin united to a ſmall portion of iron. Tin alloyed with $\frac{1}{21}$ of iron was very malleable, might be cut with a knife, had loſt a little of its luſtre, and was a little harder. With the fuſible phoſphates it gave a brown glaſs, which was leſs fuſible; and by the addition of nitric acid, it became black, and there was ſeparated an inſoluble powder. Iron combined with half its weight of tin, exhibits ſome of the properties of the latter. It is ſlightly malleable, cannot be cut with a knife, unites with difficulty with mercury and with the phoſphates, and in fuſion with the latter, gives out brilliant ſparks, which do not appear from the iron or tin alone. This inflammation is ſtill more brilliant when the quantity of tin is increaſed to $\frac{11}{100}$.

1955 Tinplate. Tin combines with iron, and adheres ſtrongly to its ſurface, forming a thin covering. This is one of the moſt uſeful combinations of tin, for it renders the iron fit for a great many valuable purpoſes, for which, otherwiſe, on account of its ſtrong tendency to oxidation or ruſting, it would be totally inapplicable. This is well known by the name of *tinplate*, or *white iron*.

1956 Proceſs of tinning. The proceſs of tinning iron is the following: The plates of iron being reduced to the proper thickneſs, are cleaned by means of a weak acid. For this purpoſe the ſurface is firſt cleaned with ſand, to remove any ruſt that may have formed. They are then immerſed in water acidulated with a ſmall quantity of ſulphuric acid, in which they are kept for 24 hours, and occaſionally agitated. They are then well rubbed with cloths, that the ſurface may be perfectly clean. The tin is fuſed in a pot, the ſurface of which is covered with an oily or reſinous matter, to prevent its oxidation. The plates of iron are then immerſed in the melted tin, and are either moved about in the liquid metal, or are dipped ſeveral different times. They are then taken out, and rubbed with ſaw-duſt or bran, to remove the impurities from the ſurface.

It is ſaid by ſome chemical writers, that the tin not only covers the ſurface, but penetrates the iron completely, ſo as to give the whole a white colour. This ſeems to be quite a miſtake, which may be very eaſily proved by the teſt of experiment. If the ſurface of a piece of tin-plate be ſcraped with a knife, the metallic particles which are at firſt ſeparated, are not attracted by the magnet. As the proceſs is continued, ſome of the particles are magnetic, which ſhews that they are particles of iron, ſcraped off, after the coating of tin is ſeparated, and this coating may be ſo completely removed, that the whole of the particles are attracted by the magnet. This perhaps, it may be ſaid, would take place, even though the iron were alloyed with a certain proportion of tin; but when the coating of tin is entirely removed, and the iron is moiſtened, it is ſoon covered with ruſt, in the ſame way as if it never had been combined with a particle of tin.

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* Phil. Mag. xiii. 406.

1957 Lead. 11. Guyton has ſhewn, that an alloy may be formed of iron and lead, which it was formerly ſuppoſed could not be effected. By melting together equal parts of lead and filings of iron, he obtained two ſeparate metallic buttons, of which the lead occupied the lower part of the crucible, and the iron the upper part. When theſe were ſubjected to the teſt of experiment, it appeared that the lead contained a ſmall proportion of iron, and the iron a ſmall proportion of lead *.

The uſes of iron are extremely numerous and important, but they are ſo well known, that it is altogether unneceſſary to enumerate them.

Sect. XIX. *Of Copper and its Combinations.*

1958 Hiſtory. 1. Copper ſeems to have been known in the remoteſt periods of antiquity. It is among the firſt metals which was employed by the early nations of the world; and indeed this might have been expected, as it is not one of the ſcarce metals, is eaſily extracted from its ores, and not difficult to work. The Egyptians applied it to a great variety of uſes, as it appears from the earlieſt period of their hiſtory. The Greeks were acquainted with the mode of working copper, and employed it in many of the arts. It was the baſis of the celebrated Corinthian metal. The Romans knew the uſes of this metal, and it is generally ſuppoſed that of it they fabricated the greateſt number of their utenſils. The alloys which they made with copper, after the example of the Egyptians and Greeks, were very numerous, and applied to a great variety of uſes.

1959 Ores. 2. Copper exiſts in conſiderable abundance in nature; it is found native, alloyed with other metals, combined with ſulphur, in the ſtate of oxide, and in that of ſalt. It is not unfrequently met with in the native ſtate, ſometimes cryſtallized in an arboreſcent form, and ſometimes in more regular figures. Copper exiſts native, alloyed with gold and ſilver. The moſt abundant ores of copper are the ſulphurets, and of theſe there is a conſiderable variety, exhibiting various colours, and various forms of cryſtals. In the ſtate of oxide, it has been found in Peru, of a greeniſh colour, mixed with white ſand. In the ſtate of ſalt, copper is combined with the ſulphuric and carbonic acids, forming native ſulphates and carbonates of copper. The latter preſent many varieties, but may chiefly be referred to the blue and green carbonates.

1960 Analyſis. 3. The extraction of the ores of copper is to be conducted according to the nature of the combination in which they exiſt. The following proceſs is recommended for the treatment of the ſulphurets of copper. The ore is firſt reduced to powder, and then boiled with five parts of concentrated ſulphuric acid. The ſolution is evaporated to dryneſs, and the reſiduum well waſhed with warm water, to remove all ſoluble matters. The ſolution being ſufficiently diluted, a plate of copper is immerſed in it, which precipitates the ſilver, and afterwards a plate of iron to precipitate the copper. It is boiled with the plate of iron, till no farther precipitate takes place. The copper which is thus obtained, is dried with a gentle heat, ſo that it may not undergo oxidation. It is ſuppoſed that the copper is mixed with iron, the whole may be diſſolved in nitric acid, and the proceſs is again repeated by introducing the plate of iron. In this way it is eaſy to diſcover the quantity of copper in the ſulphurets of this metal.

1961 Properties. Copper is a very brilliant metal, of a fine red colour, different from every other metallic ſubſtance. The ſpecific gravity of copper is 8.584. When it is hammered, it acquires a greater denſity. It poſſeſſes a conſiderable degree of hardneſs, and ſome elaſticity. It is extremely malleable, and may be reduced to leaves ſo fine that they may be carried about by the wind. It has alſo a conſiderable degree of ductility, intermediate, according to Guyton, between tin and lead. The tenacity of copper is alſo very great. A wire .078 of an inch in diameter, will ſupport a weight without breaking equal to more than 300lbs. avoirdupois. Copper has a peculiarly aſtringent and diſagreeable taſte. It is extremely deleterious, when taken internally, to the animal economy, and indeed may be conſidered as a poiſon. It is diſtinguiſhed by a peculiarly diſagreeable odour, which it communicates to the hands by the ſlighteſt friction.

1962 Action of heat. 5. Copper does not melt till the temperature is elevated to a red heat, which is about 27° Wedgwood, or by eſtimation 1450° Fahrenheit. When it is rapidly cooled after fuſion, it aſſumes a granulated and porous texture, but if it be cooled ſlowly, it affords cryſtals in quadrangular pyramids, or in octahedrons, which proceed from the cube, its primitive from. When the temperature is raiſed beyond what is neceſſary for its fuſion, it is ſublimed in the form of viſible fumes.

1963 Oxidation. 6. When copper is expoſed to the air, eſpecially if it be humid, it is ſoon deprived of its luſtre. It tarniſhes, becomes of a dull brown colour, which gradually deepens, till it is converted into that of the antique bronze, and at laſt is covered with a ſhining green cruſt, which is well known under the name of *verdigris*. This proceſs is the oxidation of the metal by the abſorption of oxygen from the atmoſphere; and it is promoted and accelerated, either by being moiſtened with water, or by the water which exiſts in the atmoſphere. As this oxide is formed, the carbonic acid of the atmoſphere combines with it, ſo that it is to be conſidered as a mixture of oxide and carbonate of copper.

7. But when copper is ſubjected to a ſtrong heat, the oxidation proceeds more rapidly. If a plate of copper be made red-hot in the open air, it loſes its brilliancy, becomes of deep brown cocolour, and the external layer, which is of this colour, may be detached from the metal. This is the brown oxide of copper. This oxide may be obtained by immerſing a plate of red-hot copper into cold water. The ſcales which are formed on the ſurface fall off by the ſudden contraction of the heated copper. This may be repeated till the whole is converted into this oxide. The copper in this ſtate is in the higheſt degree of oxidation. Sometimes it aſſumes a black, and ſometimes a green colour, which, according to Prouſt, are owing to the combination of carbonic acid with the oxide. This oxide of copper may alſo be obtained by diſſolving

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* *Ann. de Chim.* xliii. 48.

1964 Black oxide. diſſolving copper in nitric or ſulphuric acid, and then by precipitating with an alkali, which precipitate is to be dried, to ſeparate the water. The component parts of this oxide are,

Oxygen	25
Copper	75
	100

But copper combines with a ſmaller proportion of oxygen, forming an oxide of an orange colour. If the black oxide of copper be mixed with leſs than an equal proportion of metallic copper in fine powder, triturated in a mortar, and introduced into a cloſe veſſel with muriatic acid, the whole of the copper is diſſolved with the emiſſion of heat, and the oxide is precipitated of an orange colour, by means of potaſh. This is the oxide of copper with the ſmaller proportion of oxygen. The component parts of this oxide according to Mr Chenevix, are

1965 Yellow.

Oxygen	11.5
Copper	88.5
	100.0*

This oxide changes colour the moment it is expoſed to the air, by the abſorption of oxygen, for which it has a very ſtrong affinity.

8. There is no action between azote, hydrogen, or carbone, and copper.

1966 Phoſphuret. 9. Phoſphorus readily combines with copper, and forms with it a phoſphuret, which is prepared by fuſing equal parts of copper and phoſphoric glaſs, with $\frac{1}{8}$ of the whole of charcoal in powder. Or, it may be formed by projecting phoſphorus on red-hot copper in a crucible. The phoſphuret of copper is of a whitiſh gray colour, with a metallic luſtre, and of a cloſe texture. It is much more fuſible than copper; it melts by the action of the blow-pipe; the phoſphorus burns with deflagration on the ſurface, and the copper remains behind in the ſtate of black ſcoria. Expoſed to the air, it loſes its brilliancy, blackens, and is converted into a kind of effloreſcence, which is phoſphate of copper. It is compoſed of 20 parts of phoſphorus, and 80 of copper.

1967 Sulphuret. 10. Copper combines with ſulphur by different proceſſes. If ſulphur in powder and filings of copper are mixed together, and formed into a paſte with a little water, when they are expoſed to the air, the maſs ſwells up, becomes hot, and is converted into a brown matter, which effloreſces ſlowly in the air, and is converted into ſulphate of copper. This ſulphuret may be alſo formed by heating together in a crucible, equal parts of ſulphur and copper filings. A deep coloured maſs is thus obtained, which is brittle, and more fuſible than copper. This ſubſtance, which is employed in dyeing, is prepared by ſtratifying in a crucible plates of copper and ſulphur. When the whole is melted, it is afterwards reduced to powder, and was formerly known by the name of *æs veneris*.

1968 Singular experiment. A ſingular and ſplendid experiment was firſt made by the ſociety of Dutch chemiſts at Amſterdam, in the formation of ſulphuret of copper. If three parts of flowers of ſulphur, by weight, and eight parts of copper filings, be mixed together, introduced into a glaſs matraſs, and then placed upon red-hot coals, the mixture melts, and afterwards, with a kind of exploſion, becomes almoſt inſtantaneouſly red-hot. If it be then removed from the fire, it continues red-hot for ſome time, and is converted into a ſulphuret of copper. The ſingular part of this experiment is, that it ſucceeds equally well without the acceſs of oxygen: or even it may be performed, when the mixture is under water. It ſeems, therefore, at firſt ſight, to be a caſe of combuſtion, or apparent combuſtion, without oxygen. 1969 Of difficult explanation. Various opinions have been entertained concerning the nature of this proceſs, and different theories have been propoſed to account for the phenomena, which are ſeemingly irreconcileable with the preſent theory of combuſtion. Indeed it was at firſt held up as an objection to the Lavoiſierean theory. It has been explained by ſome, by ſuppoſing that a ſmall quantity of air may have remained within the apparatus, or mixed with the materials; or that the quantity of air neceſſary might be ſupplied from the moiſture, from which the materials and the apparatus may not have been ſufficiently freed. But this affords no ſatisfactory explanation; for the quantity of air or water which could remain when the experiment has been carefully performed, is not ſufficient to furniſh the neceſſary portion of air for the ſupport of ſuch a vivid combuſtion. Fourcroy conſiders it as a caſe of ſimple phoſphoreſcence, a change or ſudden increaſe of capacity for caloric, or as merely the ſeparation of light, or the converſion of caloric into light; and in ſupport of this opinion he ſtates, that the compound is always ſulphuret of copper, which would not have been the caſe, had real combuſtion been effected, for then it would have been a ſulphate of copper. But it is explained by others according to the principles of the theory of combuſtion, which has been given by Gren, and which we have already detailed, in treating of heat. According to this theory, the light exiſts in combination with the combuſtible, which in this caſe is the copper. When heat is applied to the mixture, the ſulphur melts, and therefore combines with a great quantity of caloric; but, when the ſulphur combines with the copper, it returns to the ſolid ſtate, and therefore gives out a quantity of caloric. The light from the metal at the ſame time combines with the caloric, and both appear in the form of fire. It is at the inſtant of combination that the maſs becomes red-hot, in conſequence of the ſudden extrication of heat and light from the two ſubſtances which form the compound.

1970 Copper pyrites. Copper combined with ſulphur, is one of the moſt common ores of this metal. According to the experiments of Prouſt, the natural production, known by the name of copper pyrites, is a ſulphuret of copper, combined with an additional portion of ſulphur. It is diſtinguiſhed by its brittleneſs, metallic luſtre, and yellow colour.

1971 Affinities. 11. The order of the affinities of copper and its oxide, is according to Bergman the following:

Copper.	Oxide of Copper.
Gold,	Oxalic acid,
Silver,	Tartaric,
Arſenic,	Muriatic,
Iron,	Sulphuric,
Manganeſe,	Saclactic,
Zinc,	Nitric,

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* Phil. Tranſ. 1801, p. 235.

COPPER.	OXIDE of COPPER.
Antimony,	Arſenic,
Platina,	Phoſphoric,
Tin,	Succinic,
Lead,	Fluoric,
Nickel,	Citric,
Biſmuth,	Lactic,
Cobalt,	Acetic,
Mercury,	Boracic,
Sulphur,	Pruſſic,
Phoſphorus.	Carbonic.

I. Salts of Copper.

1. Sulphate of Copper.

1972 Preparation. 1. Sulphuric acid has no action on copper in the cold; but when it is concentrated, and at a boiling temperature, it is decompoſed by the copper, with the diſengagement of ſulphurous acid gas. By evaporating the liquid, and by ſlow cooling, cryſtals of a fine blue colour are obtained. This ſalt, which is a ſulphate of copper with exceſs of acid, reddens vegetable blues, has a ſtrong ſtyptic, metallic taſte, and is at the ſame 1973 Properties. time extremely acrid and cauſtic. Its ſpecific gravity is 2.1943. It is ſoluble in 4 parts of cold, and in 2 of boiling water. It effloreſces ſlightly in the air, loſes its water of cryſtallization when it is heated, and is converted into a bluiſh white powder. By increaſing the heat the acid is driven off, and the oxide remains behind. The component parts of this ſalt are, accord- 1974 Compoſition. ing to Prouſt,

Acid,	33
Oxide,	32
Water,	35
	100

1975 Native. 2. This ſalt is generally found in great abundance in nature, and is obtained either by evaporating the water which holds it in ſolution, or by expoſing the ſulphuret of copper to air and moiſture, by which it is converted into ſulphate of copper. This ſalt is known in commerce by the names of *blue vitriol*, *blue copperas*, and *vitriol of copper*.

3. None of the acids have any action on the ſulphate of copper. It is decompoſed by the alkalies and earths, and precipitated in the form of a bluiſh-gray oxide, which becomes green when expoſed to the air, by abſorbing carbonic acid from the atmoſphere. Ammonia decompoſes and precipitates the ſulphate of copper, and, with an exceſs of alkali, diſſolves the oxide, which aſſumes a rich, brilliant blue colour. It is alſo partially de- 1976 Sympathetic ink. compoſed by muriate of ammonia. Equal parts of this ſalt and ſulphate of copper in a heated ſolution, appear of a yellow colour, but when the ſolution cools, it is converted into green. This ſolution has been employed as a ſympathetic ink. Paper moiſtened with it, appears of a yellow colour when it is heated, but, in the cold, the colour entirely diſappears.

4. When a ſmall quantity of cauſtic potaſh is added to a ſolution of ſulphate of copper, a greeniſh-coloured precipitate is formed, which is diffuſed in the ſolution. This is a ſulphate of copper with exceſs of baſe, and, according to Prouſt, is compoſed of

1977 Compoſition of.

Acid,	18
Oxide,	68
Water,	14
	100

Copper is reduced to the metallic ſtate from its ſolutions in acids, by ſeveral metallic ſubſtances, as iron, zinc, tin. If a plate of iron be introduced into a ſolution of copper in an acid, the iron is in a ſhort time covered with metallic copper. It is in this way that copper is obtained from its natural ſolutions in water.

2. Sulphite of Copper.

1978 Preparation. Sulphurous acid has no action whatever on copper; but the oxide of copper readily combines with this acid. Or, the ſulphite of copper may be formed by adding a ſolution of ſulphite of ſoda, to a ſolution of ſulphate of copper. An orange-yellow precipitate is formed, and ſmall cryſtals of a greeniſh white are depoſited. Theſe become deeper coloured by expoſure to the air. Both the yellow precipitate and the greeniſh white ſalt have been proved by experiment to be ſulphites of copper. The firſt contains a greater proportion of copper, and therefore has an exceſs of baſe, to which its colour and inſolubility are owing. The ſecond is a ſaturated ſulphite, which is ſoluble and cryſtallizes. When theſe ſalts are heated by the blow-pipe, they melt, blacken, aſſume a grayiſh colour, and are at laſt reduced to the metallic ſtate. By the addition of nitric acid they are converted into ſulphate of copper. By the ſulphuric acid the ſulphurous acid is driven off, and there remains behind a browniſh-coloured matter in the ſtate of powder, which is the oxide of copper mixed with a portion of that metal in the metallic ſtate.

3. Nitrate of Copper.

1979 Preparation. 1. Nitric acid is decompoſed by copper with great rapidity. Nitrous gas is given out in great abundance, the metal is oxidated, and diſſolved in the acid. The ſolution, which is at firſt of a pale blue, aſſumes a deep colour, and by ſlow evaporation yields cryſtals in the form of long parallelopipeds. This ſalt has an acrid ſtyptic taſte, is extremely cauſtic, and corrodes the ſkin. It is deliqueſcent, and very ſoluble in water. 1980 Properties. This ſalt expoſed to a heat, even under 100°, melts; by increaſing the heat, the water of cryſtallization is driven off; it detonates ſlightly on red-hot coals, and when mixed with phoſphorus, by percuſſion.

1981 Violent action on tin. 2. If a quantity of this dried ſalt, reduced to powder, be ſpread on a ſheet of tinfoil, it remains without any action; but if it be moiſtened a little with water, and wrapped up, a violent action takes place. The ſalt is decompoſed, and nitrous gas is diſengaged with a great degree of heat. The tinfoil is burſt to pieces, and ſometimes it is even inflamed. In this proceſs, the nitric acid of the nitrate of copper is decompoſed, in conſequence of the ſtrong affinity of the tin for the oxygen of the acid. The tin is oxidated, nitrous gas is given out, and the copper is partly reduced to the metallic ſtate.

1982 Decompoſition of. 3. The alkalies and earths precipitate the ſolution of nitrate of copper in the form of a bluiſh white oxide, which becomes green by expoſure to the air. When it is precipitated by means of potaſh, if the potaſh predominate, a bulky precipitate is formed, of a fine blue colour. The precipitate is compoſed of the oxide of copper and water, from which Prouſt, who particularly examined it, has denominated it *hydrate of copper*. Lime thrown into this ſolution, has the property of giving it a deeper ſhade of blue. It is by this proceſs that the blue pigment known in commerce by the name of *verditer*, and which is employed for painting paper, is prepared.

4. If nitrate of copper be diſtilled in a retort, the ſalt becomes thick, and forms a green cruſt on the retort. It is then in the ſtate of nitrate with exceſs of baſe, or *ſubnitrate*, which is inſoluble in water.

1983 Compoſition. 5. The component parts of this ſalt are, according to Prouſt,

Acid,	16
Oxide,	67
Water,	17
	100

4. Muriate of Copper.

1. Concentrated muriatic acid, with the aid of heat, acts on copper and diſſolves it. It produces a ſlight effervescence, with the evolution of hydrogen gas. 1984 Preparation. The ſolution is of a fine green colour, by which it is diſtinguiſhed from the ſulphate and nitrate of copper. This ſalt may be formed by the direct combination of the green oxide of copper with muriatic acid, a little diluted with water. By evaporation and ſlow cooling, cryſtals may be obtained in the form of long ſmall needles, or rectangular parallelopipeds, which are of a fine graſs-green colour. 1985 Properties. This ſalt is extremely acrid and cauſtic; it melts with a moderate heat; it is deliqueſcent in the air, and is ſoon converted into a thick liquid like oil. The ſalt fuſes at a moderate heat, and becomes of a uniform maſs by cooling. It is not decompoſed by ſulphuric or nitric acids. The alkalies precipitate a bluiſh white oxide, which becomes green in the air; the copper is precipitated by zinc and iron. 1986 Compoſition. The component parts of this ſalt, according to Prouſt, are,

Acid,	24
Black oxide,	40
Water,	36
	100

This ſalt is therefore the muriate of copper with the oxide in the higheſt degree of oxidation.

1987 Submuriate. 2. This ſalt, according to the experiments of Prouſt, may be diſtilled to dryneſs without any change; but by increaſing the heat, a part of its acid is driven off in the ſtate of oxymuriatic acid, and the copper remains behind in its loweſt ſtate of oxidation, and forms a muriate of copper of a white colour. This muriate may alſo be obtained by diſſolving copper in nitro-muriatic acid. A greeniſh powder appears, which is a muriate of copper with exceſs of baſe. The component parts of this ſalt are,

1988 Compoſition.

Acid	12.5
Oxide	79.0
Water	8.5
	100.0

1989 With the orange oxide. 3. Muriatic acid alſo forms a ſalt with the oxide of copper in its loweſt degree of oxidation. Prouſt obtained this ſalt by mixing ſalts of copper with muriate of tin, which latter deprived the copper of a portion of its oxygen, and afforded a ſalt of a white colour. It may be formed alſo by introducing a plate of copper into a bottle filled with muriatic acid. This ſalt cryſtallizes in tetrahedrons. It may be precipitated in the ſtate of white powder; by diluting the ſolution with water, and by repeated waſhings, the orange oxide of copper is obtained. When it is expoſed to the air, it ſoon combines with oxygen, and is converted into muriate of copper with the oxide in its maximum ſtate of oxidation. This ſalt is ſoluble in ammonia, and forms with it a colourleſs ſolution, which, after being for ſome time expoſed to the air, aſſumes a fine blue colour by the abſorption of oxygen.

5. Hyperoxymuriate of Copper.

The oxide of copper diffuſed in water, is diſſolved, when a ſtream of oxymuriatic acid gas is directed through it. But the properties of this ſalt were not examined by Mr Chenevix, who formed it.

6. Fluate of Copper.

Fluoric acid readily oxidates and diſſolves copper; but the properties of this ſalt are little known. It forms a gelatinous ſolution, and affords by evaporation cubical cryſtals.

7. Borate of Copper.

This ſalt is moſt readily formed by adding a ſolution of an alkaline borate to the ſolution of nitrate or ſulphate of copper. A greeniſh precipitate is formed, which has very little ſolubility in water.

8. Phoſphate of Copper.

1990 Preparation. Phoſphoric acid is not decompoſed by copper; but when it remains for ſome time in contact with the metal, it promotes the oxidation, and there is thus formed a phoſphate of copper, which has little ſolubility. Or it may be obtained by pouring an alkaline phoſphate into a ſolution of ſulphate or nitrate of copper. The phoſphate of copper is formed, which is almoſt inſoluble. When it is heated with charcoal in a crucible it affords a gray phoſphuret of copper, which has ſome brilliancy. The component parts of phoſphate of copper, as they have been aſcertained by Mr Chenevix, are, 1991 Compoſition.

Acid,	35.0
Oxide,	61.5
Water,	3.5
	100.0

The above oxide is compoſed of 49.5 brown oxide, and 12 of water.

9. Carbonate of Copper.

1992 Preparation. Carbonic acid has no action on copper, either in the gaſeous or liquid ſtate; but it is very readily abſorbed by the blue or green oxides of this metal. It may be formed by adding an alkaline carbonate to any of the ſolutions of copper in the other acids. To prepare this ſalt of the moſt brilliant and uniform colour, it ſhould be precipitated with boiling water, waſhed carefully, and the veſſel which contains it placed in the ſun. The carbonate of copper is found native, and is known by the name of *malachite*. It contains the ſame proportions as the artificial carbonate. Its component parts are,

1993 Compoſition.

Acid	25.0
Brown oxide	69.5
Water	5.5
	100.0

10. Arſeniate of Copper.

This ſalt may be formed by adding a ſolution of an alkaline arſeniate to nitrate of copper; or, by digeſting arſenic acid on copper. A green ſolution is obtained, and the arſeniate of copper is precipitated in the form of a bluiſh-white powder. The arſeniate of potaſh added to a ſolution of ſulphate of copper forms a precipitate of a very rich green, which was propoſed by Scheele as a paint, becauſe it is unaltered by the air, and hence it obtained the name of *Scheele's green*. It is the arſenite of copper. This ſalt may be formed by the following proceſs:

1994 Scheele's green.

Diſſolve a quantity of potaſh in water, and add white oxide of arſenic, till the potaſh is ſaturated. Filter the liquor, and add gradually a ſolution of ſulphate of copper while it is hot, ſtirring the mixture during the addition. It is then left at reſt for ſome time, after which the arſenite of copper precipitates in the form of a beautiful green powder. The precipitate is to be repeatedly waſhed with water, and dried. Several varieties of the arſeniates of copper have been deſcribed, and analyzed by the Count de Bournon and Mr Chenevix, and an account of them publiſhed in the Philoſophical Tranſactions for 1801.

11. Tungſtate of Copper.

Tungſtic acid combines with oxide of copper, or forms a precipitate when added to a ſolution of ſulphate of copper.

12. Molybdate of Copper.

Molybdic acid added to a ſolution of nitrate of copper, produces a green precipitate.

13. Chromate of Copper.

This is formed by adding chromic acid to a ſolution of nitrate of copper. A red precipitate is obtained.

14. Acetate of Copper.

1995 Preparation. Copper is readily oxidated and diſſolved in acetic acid. The ſolution is aided by heat, and gradually aſſumes a green colour. The oxide of copper, which is thus formed, is the verdegris of commerce. It is uſually prepared by expoſing plates of copper to the action of vinegar. The ſurface of the plates is covered with this bluiſh green powder, which being diſſolved in acetic acid affords a ſolution of a fine greeniſh blue colour. This ſolution by evaporation and cooling gives cryſtals of a deep blue colour, and in the form of quadrangular, truncated pyramids. The ſpecific gravity is 1.779. This ſalt has a ſtrong diſagreeable taſte, and is poiſonous. It effloreſces in the air, and is very ſoluble in water. It is decompoſed by all the alkalies; and by means of heat, or by diſtillation, it is decompoſed, and gives out acetic acid. This ſalt, according to the analyſis of Prouſt, is compoſed of

1996 Properties.

Acid and water	61
Oxide	39
	100

15. Oxalate of Copper.

Oxalic acid readily acts upon copper, and forms with it needle-ſhaped cryſtals of a green colour. It readily combines with the oxide of copper, and is then in the ſtate of a bluiſh green powder, which is little ſoluble in water. Oxalic acid precipitates the ſulphate, nitrate, and muriate of copper, in the form of a bluiſh gray powder.

16. Tartrate of Copper.

Tartaric acid diſſolves copper, when expoſed to the air, and at laſt converts it into an oxide. It combines readily with the oxide of copper, and forms with them a ſalt of little ſolubility, and of a green colour. When this acid is added to the ſolution of ſulphate or muriate of copper, it forms a tartrate of copper, which appears after ſome time in irregular greeniſh cryſtals.

17. Tartrate of Potaſh and Copper.

This triple ſalt may be prepared by boiling together oxide of copper and tartar in water. By evaporating the ſolution blue cryſtals are obtained, which have a ſweetiſh taſte. If the ſame ſolution be evaporated to dryneſs, a bluiſh green powder remains behind, which is employed as a paint by the name of *Brunſwick green*.

1997 Brunſwick green.

18. Citrate of Copper.

Citric acid diſſolves the oxide of copper at the boiling temperature. The ſolution affords by evaporation, greeniſh coloured cryſtals.

19. Benzoate of Copper.

Benzoic acid readily diſſolves the oxide of copper. The ſolution yields ſmall cryſtals of a deep green colour, which have little ſolubility in water. It is decompoſed by the alkalies, the carbonates of lime, and barytes, and the acid is driven off by heat.

20. Succinate of Copper.

When ſuccinic acid is long digeſted with copper, it diſſolves a ſmall portion, and the ſolution affords green cryſtals.

21. Suberate of Copper.

When ſuberic acid is added to a ſolution of nitrate of copper, it produces a green colour; but there is no precipitate.

22. Mellate of Copper.

When mellitic acid is added to a ſolution of acetate of copper it affords a precipitate, and the colour of verdigris, but it produces no change on muriate of copper.

23. Lactate of Copper.

Lactic acid, after digeſtion with copper, firſt aſſumes a blue colour, then changes to a green, and is afterwards converted into a dark brown. The ſolution does not yield cryſtals.

24. Pruſſiate of Copper.

1998 Preparation. The pruſſiates of potaſh precipitate the ſalts of copper of different colours. The pruſſiates obtained from ſulphate, nitrate, and muriate of copper, Mr Hatchet obſerves, are very beautiful; but the fineſt and deepeſt colour he obtained from the muriate. He has propoſed the pruſſiate of copper as a paint; and on trial with oil and water, it has been found to anſwer the purpoſe. The method which he recommends for the preparation of this pigment, is to take green muriate of copper with 10 parts of diſtilled or rain water, and to add pruſſiate of lime, which he thinks is preferable to pruſſiate of potaſh, until the whole is precipitated. The pruſſiate of copper is then to be well waſhed with cold water, and to be dried without heat *.

II. Action of Alkalies, &c. on Copper.

1999 Fixed alkalies. 1. The fixed alkalies in ſolution in water, digeſted with copper filings, and allowed to cool, promote the oxidation of the metal. The liquid aſſumes a ſlight blue colour, as well as the copper, but the action of the air is neceſſary for this proceſs. It ſcarcely ſucceeds in cloſe veſſels.

2000 Ammonia. Liquid ammonia, treated in the ſame way, becomes of a brilliant blue colour, but it diſſolves only a very ſmall quantity of the oxide. By the ſlow evaporation of this ſolution, the greateſt part of the ammonia is ſeparated in the form of gas; a very ſmall quantity only remains combined with the oxide of copper. This ſolution, it has been ſaid, yields tranſparent cryſtals of a fine blue colour. The dried maſs aſſumes a green colour when it is expoſed to the air, as the ammonia is diſſipated, and the oxide abſorbs carbonic acid. The green oxide of copper is inſtantly converted to a blue. This action is promoted by heat, and when the heat is increaſed, azotic gas is diſengaged; the hydrogen of the ammonia combines with part of the oxygen of the oxide and forms water; the oxide becomes of a brown colour, and the metal is at laſt revived.

2001 Glaſs coloured. 2. There is no action between the earths and copper, excepting by fuſion. With the vitrifiable earths and the oxides of this metal, a glaſs is formed, which is moſt commonly of a fine green colour, with different ſhades of brown or red, according to the degree of oxidation. The oxides of copper are frequently employed to colour glaſs, porcelain and pottery.

2002 Sulphates. 3. Copper ſeems to have but a feeble action on moſt of the ſalts. The ſulphates are not decompoſed by this metal, even with the aſſiſtance of heat. When copper is boiled with the ſolution of alum, it is oxidated and partially diſſolved, by the exceſs of ſulphuric acid which this ſalt contains. The ſulphate of copper thus formed, ſeems to combine in the ſtate of triple ſalt with the ſulphate of alumina and potaſh. It has been obſerved that alumina precipitated from alum, the ſolution of which has been kept for ſome time in copper veſſels, is ſlightly tinged with a blue colour. 2003 Nitrates. The nitrates, eſpecially the nitrate of potaſh, when fuſed together, give out ſparks, but without inflammation or detonation. A brown oxide of copper is thus formed, mixed with potaſh. When it is waſhed with water, the alkali is diſſolved, and there remains the pure oxide of copper, which is often prepared in this way for the fabrication of enamels.

2004 Muriates. Muriate of ammonia is decompoſed by copper with the aſſiſtance of heat. Hydrogen gas and ammoniacal gas are diſengaged, and there remains behind a muriate of copper. The ſolution of muriate of ammonia alſo acts upon copper, and becomes of a blue colour, when it is kept in veſſels of this metal. When muriate of ammonia is ſublimed with about $\frac{1}{60}$ of its weight of green oxide of copper, a ſmall quantity of the muriate of ammonia is decompoſed, and the muriate of copper which is formed, combines with the undecompoſed ſalt. This was formerly called *cupreous flowers of ſal ammoniac*, or *ens veneris*. If a quantity of lime water, with about $\frac{1}{16}$ of its weight of muriate of ammonia, be kept in a copper veſſel for 10 or 12 hours, the liquid aſſumes a fine blue colour. This was formerly called *celeſtial water*. In this proceſs a ſmall quantity of ammonia is diſengaged by the lime, and it diſſolves ſome portion of the copper, which communicates a blue colour to the whole ſolution. This compound may alſo be formed, by adding a ſmall quantity of copper filings to a mixture of the ſolution of muriate of ammonia and lime water.

4. The phoſphates, fluates, borates, and carbonates, have no other action on copper than by means of the water in which they are diſſolved. This action is greatly promoted by expoſure to the air.

III. Alloys.

1. Copper readily combines with almoſt all other metals, by means of fuſion; and many of the alloys which are thus formed, are of great importance in the arts.

2005 Arſenic. 2. When copper is combined with arſenic, by melting them together in a cloſe crucible, and covering the ſurface with muriate of ſoda, to prevent oxidation, a white brittle alloy is formed, which has been called *white tombac*. With a certain proportion of zinc and tin, this alloy is employed in the fabrication of various utenſils.

3. The alloys of copper with tungſten, molybdena, chromium, columbium, titanium, and uranium, are either altogether unknown, or have not been examined.

2006 Cobalt. 4. Little is known of the alloy of copper and cobalt. It is ſaid that it reſembles cobalt itſelf in texture and brittleneſs.

2007 Nickel. 5. Copper forms with nickel a white hard alloy, which has no ductility, and which is ſoon altered by expoſure to the air.

2008 Manganeſe. 6. Copper unites with manganeſe, and gives an alloy of a red colour, which is very malleable.

7. Equal

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* *Jour. Roy. Inſt.* i. 307.

2009 Biſmuth. 7. Equal parts of copper and biſmuth, melted together, form a brittle alloy of a pale red colour. With one-eighth of biſmuth, the alloy is extremely brittle, of a very pale red colour, and exhibiting in its texture nearly cubical fragments. The ſpecific gravity of this alloy is exactly the mean of that of the two metals; and, as the proportion of biſmuth is increaſed, the tenacity of the alloy is diminiſhed.

2010 Antimony. 8. Copper combines readily with antimony by fuſion. Equal parts of the two metals conſtitute an alloy of a beautiful violet colour, and of a greater ſpecific gravity than the mean. This alloy is remarkable for its lamellated and fibrous texture. The alchemiſts gave it the name of *regulus of Venus*. A compound formed of equal parts of martial regulus and regulus of Venus, according to an alchemical preſcription, the ſurface of which exhibits the appearance of meſhes or cavities, was called *Vulcan's net*, becauſe it ſeemed to envelope iron and copper, which were denominated *Mars* and *Venus*.

2011 Mercury. 9. Copper enters into combination with mercury with ſome difficulty. This alloy may be formed by triturating very thin plates of copper which have been rubbed with vinegar or common ſalt, with mercury; or, by triturating copper filings with the ſolution of mercury in nitric acid. It is alſo formed by other proceſſes; but whatever be the proceſs, this amalgam is of a reddiſh colour, and ſufficiently ſoft to receive the moſt delicate impreſſions when it is a little heated. It becomes hard by expoſure to the air. It is decompoſed by heat, and the mercury is ſeparated.

2011 Zinc. 10. The compound of copper and zinc conſtitutes one of the moſt important and uſeful alloys, of all the combinations of the metals. Muſchenbroeck has given a particular deſcription of ſeveral of theſe alloys. Equal parts of copper and zinc afforded a metal of a fine golden yellow, whoſe ſpecific gravity was 8.047; one part of copper and half a part of zinc, formed a compound of a pale golden colour; one part of copper and three-fourths of zinc, compoſed an alloy of a golden colour, which yielded to the file; one part of copper and one-fourth of zinc, gave a compound of a finer colour than that of braſs. According to the proportions of the metals which are employed, the alloys have received different names. The uſual proceſs for combining them, is either by fuſing copper with a mixture of calamine, or native carbonate of zinc and charcoal; or by ſtratifying plates of copper with the ſame mixture, and expoſing them to heat.

2013 Braſs. The well known compound, diſtinguiſhed by the name of *braſs*, is an alloy of copper and zinc. The proportion of the zinc is about one-fourth of the copper. This alloy is of a fine yellow colour, leſs liable to tarniſh, and more fuſible than the copper. The denſity of this alloy is one-tenth more than the mean. It is malleable, and poſſeſſes conſiderable ductility. 2014 Pinchbeck. A compound applied to a great variety of ornamental purpoſes, and known by the names of *Prince Rupert's metal*, *prince's metal* or *pinchbeck*, is an alloy of zinc and copper in the proportion of three parts of the former to four of the latter. This alloy is leſs malleable than braſs; but has a fine golden colour, which is pretty permanent, and little affected by expoſure to the air.

The compound of zinc and copper, called braſs, it is ſuppoſed, was well known to the ancients. An ore of zinc was employed in the fabrication of it, although it does not appear that they were at all acquainted with zinc as a diſtinct metal. "It is probable," Profeſſor Beckmann obſerves, after Pliny, "that ore containing zinc, acquired the name of *cadmia*, becauſe it firſt produced braſs." "Ipſe lapis è quo fit æs, cadmia vocata." "When it was afterwards remarked, that calamine gave to copper a yellow colour, the ſame name was conferred on it alſo. It appears, however, that it was ſeldom found by the ancients, and we muſt conſider cadmia in general as ſignifying ore that contains zinc. Gold-coloured copper or braſs was long preferred to pure or common copper, and thought to be more beautiful the nearer it approached to the beſt *aurichalchum* (c). Braſs, therefore, was ſuppoſed to be a more valuable kind of copper; and on this account Pliny ſays that cadmia was neceſſary for procuring copper, that is, *braſs*. Copper as well as braſs was for a great length of time called *æs*, and it was not till a late period, that mineralogiſts, in order to diſtinguiſh them, gave the name of *cuprum* to the former. Pliny ſays, that it was good when a large quantity of cadmia had been added to it, becauſe it not only rendered the colour more beautiful, but increaſed the weight (d) *."

* *Hiſt. of Invent.* iii. 74.

2015 Braſs analyzed. To diſcover the proportions of the two metals in this alloy, Vauquelin diſſolved a quantity of braſs in nitric acid. When the ſolution is completed, he precipitates the two metals by means of potaſh, which is added in large quantity, to diſſolve the whole of the oxide of zinc; and as the oxide of cepper is not ſoluble by this alkali, it remains in the form of black powder, which is ſeparated, waſhed, and dried. A fiftieth part of the weight of this precipitate is deducted for the oxygen with which it is combined; the remainder gives the weight of copper in the alloy. What is deficient of the whole weight of the alloy, is the weight of the zinc †.

† *Fourcroy Connaiſs. Chim.* vi. 159.

11. Copper

(c) According to Biſhop Watſon, the *aurichalcum*, or *orichalcum* of the ancients is to be conſidered as the ſame with our braſs. *Mancheſt. Tranſ.* ii. 47.

(d) Mr Beckmann farther adds, "at firſt it was called *æs cyprium*; but in courſe of time only *cyprium*, from which at length formed *cuprum*. It cannot, however, be aſcertained at what periods theſe appellations were common. The epithet *cupreus* occurs in manuſcripts of Pliny and Palladius, but we cannot ſay whether later tranſcribers may not have changed *cyprius* into *cupreus*, with which they were perhaps better acquainted. The oldeſt writer who uſes the word cuprum, is Spartian, who ſays in the life of Caracalla, *cancelli ex ære, vel cupro*; but may not the laſt word have been added to the text as a gloſs? Pliny, book xxxvi. 26. ſays, *addito cypreo et nitro*, which Iſidore, xvi. 15. p. 363, expreſſed by the words *adjecto cupro et nitro*." *Hiſt. of Invent.* iii. 75.

2016 Tin. 11. Copper combines very readily with tin. This is a very important alloy in the arts. It is with this alloy that *bronze*, metals for caſting ſtatues and cannons, bell-metal, and metallic mirrors, are formed. Tin diminiſhes the ductility of copper, and increaſes its tenacity, hardneſs, and ſonorous quality. According to Muſchenbroeck, copper acquires the greateſt ſolidity with the addition of one part of tin to five or ſix of this metal. By increaſing the quantity of tin, the alloy becomes hard and brittle.

2017 For cannons. To form the alloy employed for cannons, 12 parts of tin are united to 100 of copper. In fuſing the two metals for this alloy, it is neceſſary to ſtir or agitate the mixture, otherwiſe they remain uncombined. Bronze, or the metal which is uſed for ſtatues, is not different from that of which cannons are made, excepting in the proportion of tin being either more or leſs, to vary the colour.

2018 Bell-metal The component parts of bell-metal are uſually 75 of copper and 25 of tin, or three of copper and one of tin. A ſmall quantity of other metals is ſometimes detected by analyſis, in fragments of bells that have been examined, ſuch as zinc, antimony, biſmuth, and even ſilver. But theſe metals are not conſidered as eſſential to the alloy. Bell-metal is of a grayiſh white colour, of a cloſe grain, and ſo hard as to be ſcarcely touched with the file. It is alſo elaſtic and ſonorous. The ſpecific gravity is conſiderably more than the mean, and it is more fuſible than copper. A mixture of three parts of tin and one of copper, fuſed with a little arſenious acid, and black flux, gives an alloy of the colour of ſteel, very hard, and ſuſceptible of a fine poliſh, which is employed in the fabrication of mirrors for teleſcopes. But other proportions, with the addition of other metals, are employed by different opticians. Biſmuth, antimony, and ſilver, are added, to increaſe the reflecting property of the mirror.

2019 Tinning copper. Copper veſſels which are employed for the purpoſes of domeſtic economy are apt to be corroded or oxidated by the ſubſtances which are boiled or preſerved in them. To defend them from the action of theſe ſubſtances, and to prevent the terrible accidents which would otherwiſe happen to thoſe who employ any of theſe matters as food, the inſide of ſuch veſſels is covered with a thin coating of tin. This is performed by the following proceſs. The ſurface to be covered with tin, is ſcraped very clean with an iron inſtrument, or it is ſcoured with wine lees, or weak nitric acid and ſand. The tin is then applied in two ways; in the firſt way, the tin is in a ſtate of fuſion, and the ſurface is covered with ſome reſinous or oily matter, to prevent oxidation, in the ſame way as in tinning iron. The ſurface to be tinned is firſt immerſed in a ſolution of muriate of ammonia, and dried, and then dipped into the melted tin. Another method is, to heat the copper veſſel on charcoal, and then to apply to the inſide of it a quantity of tin, which is then melted; a little muriate of ammonia being thrown in at the ſame time in powder. The ſurface is then rubbed with tow. The muriate of ammonia is employed, both to clean the ſurface of the copper, and alſo to prevent the tin from being oxidated. The coating of tin which can be applied to copper is extremely thin; and it cannot by any means be increaſed, to bear a heat greater than that which melts tin. Bayen in his reſearches concerning tin, found, that a veſſel nine inches in diameter, and three lines in depth, acquired, by having its ſurface covered with tin, only 21 grains of additional weight.

In uſing veſſels thus tinned, care ſhould be taken not to allow acid ſubſtances to remain for any length of time in contact with them, becauſe the tin would be corroded, and part of the copper afterwards diſſolved, which would inevitably act as a poiſon. Pure tin ought only to be employed, at leaſt without any mixture of lead.

2020 Lead. 12. Copper combines very readily with lead by fuſion. With an exceſs of lead, the alloy is of a gray colour, is ductile, but brittle when it is hot, on account of the great difference of fuſibility of the lead and copper. This alloy is employed in the fabrication of printing types for large letters. According to Savary, the proportion for this purpoſe is 100 of lead and 20 or 25 of copper.

2021 Iron. 13. Copper combines with iron, but with much greater difficulty than with the other metals. As the proportion of iron is increaſed, the alloy becomes of a darker gray, loſes its ductility, and is more infuſible. The alloy of copper with iron has been ſuppoſed to conſtitute that variety called *hot ſhort iron*, which poſſeſſes greater tenacity than other kinds of iron, and on account of ſome peculiar properties is more applicable to a variety of purpoſes.

2022 Uſes. Next to iron, copper is of the greateſt importance, and moſt extenſive utility, of all the metals. In the metallic ſtate it is employed for a great variety of inſtruments and utenſils; ſome of its oxides and ſalts are much uſed in painting, dyeing, and enamelling; and the alloys with other metals, eſpecially with zinc and tin, are applied to many valuable purpoſes in the arts, and in domeſtic economy. But the uſes of copper in its different ſtates, and in its various combinations, are ſo familiar and well known, that it muſt appear quite unneceſſary to enumerate them.

SECT. XX. *Of SILVER.*

2023 Hiſtory. 1. Silver has been reckoned among the noble or perfect metals, and has been known from the earlieſt ages of the world. Its ſcarcity, beauty, and utility, have always rendered it an object of reſearch among mankind, ſo that the nature and properties of this metal have been long ſtudied and minutely inveſtigated. In the midſt of the rage for the tranſmutation of metals which for centuries fired the imaginations of the alchemiſts, ſilver occupied a great ſhare of their attention and labour, with the hope of diſcovering the means of converting the baſer and more abundant metals into this, which is more highly valued on account of its ſcarcity and durability. When the dawn of ſcience commenced, and its light had diſſipated the follies and extravagancies of theſe purſuits, the earlier chemiſts were much employed in examining the properties and combinations of ſilver; nor has it been overlooked or neglected by the moderns.

2024 Ores. 2. Silver which is neither in ſuch abundance nor ſo univerſally diffuſed as many other metals, exiſts in nature in five different ſtates; in the native ſtate; in that of alloy with other metals, eſpecially with antimony; in that of ſulphuret, ſulphurated oxide, muriate, and carbonate. 1. Native ſilver, which is characterized by its ductility and ſpecific gravity, is frequently tarniſhed on the ſurface, of a gray or blackiſh colour, and appears under a great variety of forms. In this ſtate it is not perfectly pure. It is uſually alloyed with a little gold or copper. 2. The alloy of ſilver and antimony, which is the moſt frequent, is diſtinguiſhed by its brittleneſs and lamellated ſtructure from native ſilver, which it reſembles in luſtre and colour. It cryſtallizes in priſms which are ſix-ſided and pretty regular. 3. The ſulphuret of ſilver which is known to mineralogiſts by the name of *vitreous ſilver ore*, is of a dark gray colour, and has ſome metallic luſtre. It is uſually cryſtallized in the form of cubes, octahedrons with angular facets, or ſometimes in the form of the dodecahedron. 4. The ſulphurated oxide of ſilver and antimony. In this ore of ſilver the ſulphur is combined with the metal in the ſtate of oxide; in the former, in the metallic ſtate. The ore is called *red ſilver ore*. It is of a deep red colour, ſometimes tranſparent, and ſometimes nearly opake, frequently having the luſtre or ſteel on the ſurface. The primitive form of its cryſtals is the rhomboidal dodecahedron. 5. The muriate of ſilver which has been long known to mineralogiſts by the name of *corneous ſilver*, is found in irregular maſſes of a grayiſh colour, frequently opake, but ſometimes ſemitranſparent. It is ſoft and very fuſible.

2025 Analyſis.

3. The analyſis of ſilver ore varies according to its nature and combinations. Native ſilver, after being broken down and waſhed, is rubbed with liquid mercury, which by ſtrong trituration diſſolves, and combines with the ſilver. This amalgam is ſubjected to preſſure, to ſeparate the exceſs of mercury. It is then diſtilled, and afterwards heated in a crucible, to volatilize the mercury, and the ſilver remains pure. When ſilver is combined with antimony and ſulphur, the ore is to be ſtrongly roaſted, to ſeparate the antimony or ſulphur. It is then melted with a proper quantity of alkaline flux. The ſulphurated oxide of ſilver and antimony may be treated in the ſame way.

2026 Silver purified by cupellation.

But by theſe proceſſes the ſilver is not in a ſtate of perfect purity. To obtain it pure, by the ſeparation of other metals, as copper or iron, it is ſubjected to the proceſs called *cupellation*. This depends on the peculiar property of lead, when it is oxidated and afterwards vitrified, of combining with the metals, and leaving the ſilver in a ſtate of purity. A ſmall flat cup made of the powder of burnt bones, which has received the name of *cupel*, is employed for this purpoſe. The ſilver to be purified is included in a plate of lead, uſually double the weight of the ſilver. The cupel is introduced under a *muffle* in the middle of the furnace. The uſe of the muffle is to increaſe the heat, by allowing the metal to be ſurrounded on all ſides with coals, and at the ſame time preventing the admixture of any part of the fuel with the fuſed matter. The heat is then to be applied ſufficiently great, that every part of the metal may be in fuſion, but not ſuch as to ſublime the lead too rapidly. As the proceſs advances, the lead is oxidated and vitrified, and having combined with all the other metals except the ſilver, ſinks into the porous cupel, and leaves the ſilver pure. The lead, which is now in the ſtate of litharge, is extracted from the cupel, and applied to the uſual purpoſes.

2027 Properties.

4. Silver is of a fine white colour, and great brilliancy. The ſpecific gravity is 10.474, and according to ſome, when it is hammered, 10.535, and ſometimes nearly 11. The hardneſs of ſilver is intermediate between iron and gold. The elaſticity of ſilver is conſiderable, and it is one of the moſt ſonorous of the metals. It poſſeſſes very great ductility and malleability. It may be beaten out into leaves $\frac{1}{160000}$ of an inch thick, and a grain of ſilver may be ſo extended as to be formed into a hemiſpherical veſſel of ſufficient capacity to hold an ounce of water, or to be drawn out into a wire 400 feet in length. The tenacity of ſilver is very great. A wire .078 of an inch in diameter, will ſupport a weight of 187 lbs. avoirdupois.

2028 Action of heat.

5. Silver is a good conductor of caloric. Its expanſive power is leſs than that of lead and tin, and greater than that of iron. When it is expoſed to a white heat, it melts. The temperature neceſſary to bring it to fuſion has been calculated at the 1000° of Fahrenheit, but according to Kirwan, it requires a higher temperature than 28° Wedgwood to melt it, although at that temperature it continues in a ſtate of fuſion. When it is cooled ſlowly after fuſion, it exhibits ſome marks of cryſtallization. It aſſumes the form of four-ſided pyramids, or of octahedrons. If the heat be increaſed after the ſilver is melted, it boils, and may be reduced to vapour. The ſurface of melted ſilver is ſo extremely brilliant, that it ſeems to throw out ſparks, which is called *coruſcation* by the workmen.

2029 Electricity &c.

8. Silver is a good conductor of electricity. It has no perceptible taſte or ſmell.

2030 Of air.

9. Silver is not altered by expoſure to the air, although it is ſoon tarniſhed, which is owing, as Prouſt aſcertained, to a thin covering of ſulphuret of ſilver, which is formed by ſulphureous vapours to which it is expoſed; but when it is ſubjected to a ſtrong heat for a long time, in an open veſſel, it combines with the oxygen of the atmoſphere, and is converted into an oxide.

2031 Oxidation.

In the experiments of Macquer, the oxidation of ſilver was effected by expoſing it for 20 times ſucceſſively in a crucible, to the ſtrong heat of a porcelain furnace. At laſt perceptible traces of oxidation were obſerved, and vitreous matter of an olive colour was obtained. In other experiments ſilver being acted on by the heat of a burning glaſs, was covered with a white powder, which was afterwards converted into a cruſt of a green colour. Van Marum paſſed electric ſhocks through ſilver wire, which was inſtantly reduced to a kind of powder, with a greeniſh white flame, and the oxide which was formed was diſſipated in vapour. The oxide of ſilver, which is formed by theſe proceſſes, is of a greeniſh or yellow colour. It is compoſed of about ten parts of oxygen, and 90 of ſilver. The oxide of ſilver is very eaſily reduced, for the affinity of oxygen for this metal is very feeble. It is decompoſed by the application of heat, and even when it is expoſed to the light. By heating it in cloſe veſſels, pure oxgyen gas is obtained, and the metal is converted to the metallic ſtate, by melting it in a crucible.

7. Azote, hydrogen, or carbone, have no action whatever on ſilver.

2032 Phoſphuret.

8. Silver combines with phoſphorus, forming a phoſphuret. One part of ſilver in filings, with two of

phoſphoric glaſs, and half a part of charcoal, expoſed to heat in a crucible, yielded a phoſphuret of ſilver which had acquired one-fourth of its primitive weight of ſilver. This phoſphuret is of a white colour, brittle, of a granulated texture, and may be cut with a knife. By throwing pieces of phoſphorus on ſilver red hot in a crucible, the metal is inſtantly melted, and the phoſphuret which is formed remains at the bottom. At the moment when the ſurface becomes ſolid, a quantity of phoſphorus is thrown out with a kind of exploſion, and the ſurface of the metal then exhibits a lamellated appearance. Pelletier, who firſt made this experiment, concludes from it, that ſilver is ſuſceptible of retaining a greater proportion of phoſphorus in combination with it, when it is in fuſion than in the ſolid ſtate, and that the ſeparation of the phoſphorus is owing to the ſudden contraction of the ſilver. A hundred parts of ſilver in fuſion retain 25 of phoſphorus, but only 15 when it becomes ſolid. Phoſphorus has the property of reducing the oxides of ſilver, and of precipitating them from this ſolution in acids, in the metallic form.

2033 Sulphuret. 9. Sulphur combines readily with ſilver, both in the dry and humid way. By ſtratifying in a crucible plates of ſilver alternately with ſulphur, and melting them rapidly, a deep violet-coloured maſs is obtained, which is more fuſible than ſilver, brittle, cryſtallized, and has a metallic luſtre. It may be cut with a knife, and has a good deal of reſemblance to vitreous ore of ſilver. When this ſulphuret of ſilver is expoſed to heat for a conſiderable time, the ſulphur is gradually diſſipated, and the ſilver remains pure and ductile. Silver combines very readily with ſulphur, when it is long expoſed to thoſe matters which gradually depoſit this ſubſtance. This effect is immediately produced, when ſilver is brought into contact with ſulphurated hydrogen gas, or when it is immerſed in water impregnated with this gas, as in natural ſulphureous waters. It is owing to the ſame cauſe that a ſilver ſpoon is tarniſhed by a boiled egg, and particularly if the egg has begun to ſpoil. Sulphurated hydrogen gas which is exhaled by the egg, is decompoſed, the ſulphur combines with the ſilver, and forms a thin layer of ſulphuret of ſilver, which is of a dark or violet colour. The ſame thing happens, when ſilver is expoſed in places that are much frequented, as in churches and theatres.

2034 Affinities. 10. Silver forms alloys with moſt of the metals, and ſalts with the acids. The order of the affinities of ſilver and its oxide, as they have been arranged by Bergman, is the following.

Silver.	Oxide of Silver.
Lead,	Muriatic acid,
Copper,	Oxalic,
Mercury,	Sulphuric,
Biſmuth,	Saclactic,
Tin,	Phoſphoric,
Gold,	Sulphurous,
Antimony,	Nitric,
Iron,	Arſenic,
Manganeſe,	Fluoric,
Zinc,	Tartaric,
Arſenic,	Citric,
Nickel,	Lactic,
Platina,	Acetic,
Sulphur,	Succinic,
Phoſphorus.	Pruſſic,
	Carbonic.

I. Salts of Silver.

1. Sulphate of Silver.

2035 Preparation. 1. Sulphuric acid has no action on ſilver in the cold, but three or four parts of the concentrated acid, boiled with one part of ſilver in filings or ſmall pieces, produce an efferveſcence, with the evolution of ſulphurous acid gas. A white powder is formed, which is entirely ſoluble in water acidulated with ſulphuric acid. With exceſs of acid, a ſolution of ſulphate of ſilver is obtained, which is colourleſs, very acrid and cauſtic. By evaporation it affords cryſtals, which are white and brilliant, and in the form of fine priſms or needles. When the ſolution is more concentrated, a depoſition is formed as it cools, and then it cryſtallizes in large white, brilliant plates, which ſeem to be compoſed of compreſſed four-ſided priſms.

2036 Properties. 2. This ſalt is not very ſoluble in water. When expoſed to heat, it melts and ſwells up; at a higher temperature it blackens, gives out ſulphurous acid, and oxygen gas, and is then reduced to the metallic ſtate. It is ſlowly decompoſed by the action of light. It is decompoſed by phoſphorus, and vapour of ſulphur in the cold, and by charcoal at a red heat. It is not altered by the action of the acids, excepting the muriatic. All the alkalies and the alkaline earths precipitate the oxide of ſilver from its ſolution in ſulphuric acid, of a dark gray or brown colour, and eſpecially in contact with light. Lime cauſes a precipitate of a greeniſh gray colour. Ammonia rediſſolves the precipitate. 2037 Decompoſition. Sulphate of ſilver is decompoſed by the muriates, phoſphates, and fluates. The carbonates give a white inſoluble precipitate of carbonate of ſilver. The alkaline ſulphurets, ſulphurated hydrogen gas, and water impregnated with this gas, decompoſe the ſulphate of ſilver, and form in its ſolution a black precipitate of ſulphuret of ſilver; for the oxide is reduced by the hydrogen, while the ſilver combines with the ſulphur.

2. Sulphite of Silver.

2038 Preparation. Sulphurous acid combines readily with the oxide of ſilver. It aſſumes the form of ſmall ſhining grains, of a pearly-white colour. It is not altered by expoſure to light. Sulphurous acid precipitates the ſolution of ſilver in nitric acid, in form of a white powder of ſulphite of ſilver. The ſame ſalt is obtained by adding a ſolution of ſulphite of ammonia to a ſolution of nitrate of ſilver. An exceſs of this ſulphite rediſſolves the precipitate, and forms a triple ſalt. This ſulphite of ammonia and ſilver expoſed to the ſun's rays, is ſoon covered with a pellicle of ſilver, and the liquid contains ſulphate of ammonia. Sulphurous acid, aided by the affinity of ammonia, deprives the oxide of ſilver of its oxygen, and is converted into ſulphuric acid, which combines with the ammonia, and forms a ſulphate. Sulphite of ſilver is decompoſed by muriate of ammonia; and the precipitate, which is formed, aſſumes a black colour, and is partly reduced. 2039 Decompoſition. When ſulphite of ſilver is expoſed to the action of the blow-pipe, it gives out ſulphurous acid, melts into a yellow maſs, and leaves behind a metallic button of pure ſilver. This ſalt has an acrid metallic taſte; it is ſoluble in the cauſtic alkalies, and forms with them a triple ſalt.

3. Nitrate of Silver.

2040 Preparation.

1. Silver diſſolves nitric acid with effervescence, in conſequence of the evolution of nitrous gas. If the ſolution be made in a tall conical veſſel, the nitrous gas, which is diſengaged from the bottom, is diſſolved in the acid, and communicates a green colour to the lower part of the liquid. If the green colour is permanent, or paſſes to a blue, the metal is contaminated with copper; but if it be mixed with gold, a purple coloured powder is depoſited at the bottom of the veſſel.

2041 Properties.

2042 Lunar cauſtic.

2. Nitric acid diſſolves more than ½ of its weight of ſilver. This ſolution is nearly colourleſs, very heavy, and extremely cauſtic. It colours the ſkin, firſt of a reddiſh purple, and then of a deep black. It produces the ſame effect on the nails, the hair, and all animal ſubſtances. It is employed to dye the hair of a black colour, but this ſhould be done with great caution. When it is diluted with water, ſo as to deprive it of its cauſticity, it has an aſtringent bitter taſte. By evaporating the ſolution till a pellicle is juſt formed on the ſurface, and by ſlow cooling, it cryſtallizes in tranſparent brilliant plates, ſometimes of a metallic luſtre, when the liquid has been expoſed to the ſun during the cryſtallization. Theſe cryſtals are not very regular. They are ſometimes ſix-ſided, ſometimes ſquare, and ſometimes triangular; but they ſeem to be compoſed of very fine ſmall priſms. The taſte is ſo extremely bitter, that it has been denominated *the gall of the metals*. It is not deliqueſcent in the air. When expoſed to the light of the ſun, it gradually blackens, and the ſilver is reduced. When it is heated in a crucible, it readily melts into a brown liquid, which ſwells up, as it is deprived of its water of cryſtallization: and in this ſtate of fuſion, if it be allowed to cool, it aſſumes the form of a deep gray, or black maſs. When the nitrate of ſilver is thus fuſed, and caſt into ſmall cylindrical moulds, the cylinders thus formed, which exhibit a radiated fracture, are well known in ſurgery by the names of *lunar cauſtic*, or *lapis infernalis*. This is generally prepared by evaporating the ſolution of nitrate of ſilver to dryneſs, without previous cryſtallization.

2043 Action of heat.

3. When nitrate of ſilver is heated in a retort, it firſt gives out nitrous gas, then very pure oxygen gas, which is afterwards mixed with azotic gas. The ſilver is reduced at the bottom of the veſſels. When a plate or cryſtal of nitrate of ſilver, well dried, is put upon burning coals, it produces a brilliant detonation; the ſilver is reduced, and adheres to the ſurface of the charcoal.

2044 Decompoſition.

2045 By hydrogen,

2046 And phoſphorus.

4. The nitrate of ſilver is very ſoluble in water, and in this ſtate it may be reduced by hydrogen gas and phoſphorus. By expoſing paper or ſilk moiſtened with a ſolution of nitrate of ſilver to hydrogen gas, the paper or ſilk is coated with metallic ſilver, in conſequence of the reduction of the ſalt by the hydrogen, which has a ſtronger affinity for the oxygen than the ſilver. The ſame effect takes place, if a cylinder of phoſphorus be immerſed in a ſolution of nitrate of ſilver. The phoſphorus combines with the oxygen of the oxide, and the ſilver is depoſited on the ſurface of the phoſphorus in the metallic ſtate. The phoſphorus may be ſeparated from the ſilver by melting it in boiling water. Theſe experiments were made by Sage and Bouillon in France, and Mrs Fulham in England.

2047 Detonation.

5. A mixture of this ſalt and phoſphorus ſtruck ſmartly with a hammer, produces a violent detonation. Nine grains of nitrate of ſilver and three of ſulphur produce no detonation, but only an inflammation of the ſulphur, when they are ſtruck with a cold hammer; but with a hot hammer, a detonation takes place, with the reduction of the ſilver.

6. Nitrate of ſilver is decompoſed by ſulphuric acid, and forms a precipitate of ſulphate of ſilver, in the ſtate of white powder. It is alſo decompoſed by ſulphurous acid. Muriatic acid produces a copious white precipitate which is very inſoluble, and is depoſited in the form of thick heavy flakes of muriate of ſilver.

7. Nitrate of ſilver is decompoſed by all the alkaline and earthy matters. A white precipitate is at firſt formed, which afterwards paſſes to an olive green; but the carbonates of the alkalies give a white precipitate which remains unaltered. Ammonia occaſions a ſparing precipitate, which is re-diſſolved by an exceſs of alkali, when there is formed a triple ſalt. But a very peculiar action takes place between ammonia and the oxide of ſilver, by which both the one and the other are decompoſed with a violent detonation. This is the celebrated *fulminating ſilver*, which was diſcovered by Berthollet in 1788. It is prepared by the following proceſs.

2048 Fulminating ſilver.

A ſolution of pure ſilver in nitric acid is precipitated by lime water. The precipitate is placed on gray paper, which abſorbs the whole of the water and the nitrate of lime. Pure cauſtic ammonia is then added, which produces an effect ſomewhat ſimilar to the ſlaking of lime. The ammonia diſſolves only part of this precipitate. It is left at reſt for 10 or 12 hours, when there is formed on the ſurface a ſhining pellicle, which is rediſſolved with a new portion of ammonia, but which does not appear, if a ſufficient quantity of ammonia has been added at the firſt. The liquid is then ſeparated, and the black precipitate found at the bottom, is put in ſmall quantities on ſeparate papers. This powder is *fulminating ſilver*, which, even while it is moiſt, explodes with great violence, when it is ſtruck with a hard body. When it is dry, it is ſufficient to touch, or rub it ſlightly, to produce an exploſion. If the liquid decanted off this precipitate be heated in a glaſs retort, it effervesces, gives out oxygen gas, and there are ſoon formed ſmall, brilliant, opaque cryſtals, which have a metallic luſtre, and which fulminate with the ſlighteſt touch, though covered with liquid, and break with violence the veſſels containing them. In this action the moſt obvious circumſtance is the tendency of the compound to decompoſition. The oxygen of the oxide combines with the hydrogen of the ammonia, and forms water, while the azote of the ammonia eſcapes in the form of gas, and the ſilver remains behind in the metallic ſtate. The violence of the exploſion is owing to the ſudden expanſion of the azotic gas. The ſhining pellicle which appears on the ſurface, is part of the ſilver, from which the ammonia has been ſeparated by the action of the air; and to have the full effect, another portion of ammonia is neceſſary to diſſolve it. Carbonate of ammonia diſſolves the oxide of ſilver precipitated by lime, with effervſcence, and the evolution of carbonic acid; but there remains enough of this acid to form a triple ſalt, which when dried, is in the form of a yellow powder, but has no fulminating property. The preparation of this dangerous powder frequently fails. A mixture of copper, the abſorption of carbonic acid by the oxide of ſilver, precipitated by means of lime, and left too long expoſed to the air, and ammonia containing a little of this acid, either diminiſh or deſtroy its fulminating property.

2049 Action of ſalts. 7. Many of the ſalts decompoſe the nitrate of ſilver. All the ſulphates produce a precipitate of ſulphate of ſilver in the form of powder. The ſame effect is produced by the other ſalts, and the effect is ſimilar to that which takes place with the acids of which they are compoſed.

2050 Of metals. 8. Moſt metallic ſubſtances have a ſtronger affinity for oxygen than ſilver has; it is therefore precipitated from its ſolution in nitric acid, either partially or entirely deprived of its oxygen, and in the metallic ſtate. 2051 Mercury. In the precipitation which takes place by means of mercury, the ſilver is reduced in an arboreſcent form, which has long retained the name of *arbor Dianæ*. 2052 *Arbor dianæ*, or ſilver tree. Different proceſſes have been recommended to effect this decompoſition. One part of ſilver, according to Lemery, is diſſolved in diluted nitric acid. The ſolution is then to be farther diluted with 20 parts of diſtilled water, and then to add two parts of mercury. It is ſaid, that it requires, by this proceſs, about 40 days for the formation of the metallic tree. Homberg gives a ſhorter proceſs, which ſucceeds ſufficiently well. It conſiſts in making an amalgam in the cold of four parts of ſilver-leaf and two of mercury. This amalgam is then to be diſſolved in a ſufficient quantity of nitric acid, and the ſolution to be diluted with 32 times the weight of the metals of water. By introducing into part of this liquid a ſmall ball of ſoft amalgam of ſilver, the formation of the tree immediately takes place. It may be formed alſo by putting a ſoft amalgam of ſilver into ſix parts of a ſolution of nitrate of ſilver, and four of a ſolution of nitrate of mercury. In theſe proceſſes one part of the mercury of the amalgam attracted by that of the ſolution, and carrying off the oxygen of the ſilver, precipitates the latter in the metallic ſtate. The precipitation of the ſilver is ſtill favoured by the affinity between it and the portion of undiſſolved mercury, and alſo part of the ſilver of the amalgam. All theſe attractions conſpire to effect the ſeparation of the ſilver, when it is depoſited in priſmatic needles, which arrange themſelves in an arboreſcent form.

2053 Copper. 9. Silver is precipitated from its ſolution in nitric acid, by means of copper. When a plate of copper is immerſed in this ſolution, diluted with its weight of diſtilled water, the ſilver is immediately ſeparated in whitiſh gray-coloured flakes. If this precipitate is ſcraped off, and well waſhed with water, afterwards fuſed in a crucible, and ſubjected to the proceſs of cupellation with lead, pure ſilver may be obtained.

4. Muriate of Silver.

2054 Preparation. Muriatic acid has no action whatever on ſilver; but by adding muriatic acid to a ſolution of ſilver in ſulphuric or nitric acid, the moment it comes in contact with theſe ſolutions, it decompoſes them, carries off the oxide of the ſilver, and forms with it a white inſoluble ſalt, which is precipitated in a kind of coagulated ſtate. The muriates alſo produce a ſimilar precipitate, and hence it is that the nitrate of ſilver is employed as a re-agent, and a moſt delicate teſt of muriates or muriatic acid in mineral waters. The muriate of ſilver, which is called *corneous ſilver* or *horny ſilver*, is extremely inſoluble in water. Expoſed to the light it becomes brown, violet, and black. By heating it gently in a matraſs, it melts like tallow, and when it becomes ſolid by cooling, it aſſumes the form of a ſemitranſparent gray ſubſtance, ſimilar to ſome kinds of horn, from which it derived its name of *luna cornea*, or horn ſilver. If it be fuſed on a ſtone, it is converted into a kind of friable matter, cryſtallized in beautiful, brilliant, and as it were metallic needles. When it is ſtrongly heated in a crucible, it filters through it, and is loſt in the fire. 2055 Compoſition. The component parts of this ſalt are, according to Prouſt,

Acid	18
Oxide	82
	100

This ſalt is not decompoſed by any of the acids, or by the pure alkalies. It is decompoſed by the alkaline carbonates. The muriate of ſilver is very ſoluble in cauſtic liquid ammonia. This ſolution, which is tranſparent and colourleſs, undergoes a remarkable change when it is expoſed to the air. As the ammonia evaporates in the air, there is formed on the ſurface a pellicle which aſſumes a brilliant, bluiſh, or irideſcent colour. This pellicle, which gradually increaſes in thickneſs, deepens in colour, and at laſt becomes of a dirty gray or black, by the contact of light. The ſubſtance thus ſeparated is the muriate of ammonia, containing a ſmall proportion of the metal reduced.

5. Hyperoxymuriate of Silver.

This ſalt may be prepared by paſſing oxymuriatic acid gas through water having the oxide of ſilver diffuſed in it. It is ſoluble in two parts of warm water, and cryſtallizes in cooling in the form of ſmall rhomboids. It is decompoſed by muriatic acid, and by nitric and acetic acids. The muriate of ſilver remains behind. Expoſed to a moderate heat, it melts, oxygen gas is given out, and the ſalt is reduced to the muriate of ſilver. With one-half its weight of ſulphur, it produces violent detonation, by ſlight percuſſion. It gives out a white vivid flaſh.

6. Fluate of Silver.

Fluoric acid diſſolves the oxide of ſilver, and forms with it an inſoluble ſalt. It is decompoſed by ſulphuric acid.

7. Borate of Silver.

Boracic acid combines with the oxide of ſilver, by adding a ſoluble borate to the ſolution of nitrate of ſilver. The whole of the ſilver is precipitated in the form of a white, heavy, inſoluble powder.

8. Phoſphate of Silver.

Phoſphoric acid diſſolves the oxide of ſilver, and precipitates it from its ſolution in nitric acid. The precipitate is a white heavy powder; with conſiderable heat it melts into a kind of greeniſh enamel. It is not ſoluble in water without an exceſs of acid. When it is heated in a retort with charcoal, it gives out a little phoſphorus, and is reduced, in great part, to phoſphuret of ſilver.

9. Carbonate of Silver.

Carbonic acid combines readily with the oxide of ſilver. It may be prepared by adding an alkaline carbonate to ſulphate or nitrate of ſilver. The carbonate of ſilver is precipitated in the form of a white powder. This ſalt, which blackens by the action of light, readily gives out its carbonic acid by heat.

10. Arſeniate of Silver.

Arſenic acid diſſolved in water, and heated with ſilver, has no action upon it; but when the water is evaporated, and the heat is increaſed to produce vitrification, arſenic is ſublimed, and there remains a white vitreous matter, which contains the ſilver oxidated, and is covered with a deep yellow-coloured glaſs. By heating water on this glaſs reduced to powder, the ſolution becomes of a brown red colour; the arſenic acid is diſſolved, and carries with it a little oxide of ſilver, which is precipitated by adding muriatic acid. The brown inſoluble powder is fuſed at a high temperature, and becomes ſemitranſparent. By continuing the heat in a crucible, the ſilver is reduced. Arſenic acid gives a brown precipitate in the ſolution of nitrate of ſilver.

11. Tungſtate of Silver.

Tungſtic acid does not ſeem to have any action on ſilver; but when added to a ſolution of nitrate of ſilver; it occaſions a precipitate in the form of white powder, but its properties have not been examined.

12. Molybdate of Silver.

2056 Molybdate. Molybdic acid produces a white, flaky precipitate in a ſolution of nitrate of ſilver. Nothing is known of the properties of this ſalt.

13. Chromate of Silver.

2057 Chromate. By adding chromate of potaſh to a ſolution of ſilver in nitric acid, a precipitate is formed, of a moſt beautiful crimſon red, which the action of light changes to purple. The precipitate, which is the chromate of ſilver, is in the ſtate of powder. When heated by the action of the blow-pipe, it becomes black, and is reduced in part to the metallic ſtate. Reduced to powder in this ſtate, it is ſtill of a purple colour; but when it is heated with the blue flame of a candle directed by the blow-pipe, it becomes green, and the ſilver is ſeparated in globules. The chromic acid, decompoſed by the hydrogen of the blue flame, paſſes to the ſtate of green oxide, and the oxide of ſilver is reduced.

14. Acetate of Silver.

2058 Acetate. Acetic acid diſſolves the oxide of ſilver. The acetate of ſilver may be prepared, by adding acetate of potaſh to a ſolution of nitrate of ſilver. The ſolution affords, on cooling, ſmall priſmatic cryſtals. This ſalt is very ſoluble in water, and has an acrid metallic taſte. When heated, it ſwells up, and is decompoſed. The acid is driven off, and the oxide remains behind.

15. Oxalate of Silver.

2059 Oxalate. Oxalic acid diſſolves a ſmall portion of the oxide of ſilver, which is precipitated from nitric acid, by means of potaſh, or, by adding oxalic acid to a ſolution of nitrate of ſilver. A white, thick, inſoluble precipitate is formed, which is oxalate of ſilver. This ſalt is ſoon changed by the action of light. When expoſed to the rays of the ſun, it becomes black; and when it is heated in a ſpoon, it undergoes a kind of detonation.

16. Tartrate of Silver.

2060 Tartrate. Tartaric acid combines with the oxide of ſilver, and forms with it a tartrate of ſilver, which becomes black by expoſure to the air. This acid has no action on ſilver itſelf, nor does it produce a precipitate in the ſolution of nitrate of ſilver.

17. Tartrate of Potaſh and Silver.

When tartar is added to a ſolution of nitrate of ſilver, there is formed according to Thenard, a triple ſalt, which conſiſts of tartaric acid, oxide of ſilver, and potaſh.

It is decompoſed by the alkalies and alkaline carbonates, and by the ſulphates, and muriates *.

18. Citrate of Silver.

2061 Citrate. Citric acid diſſolves the oxide of ſilver, and forms with it an inſoluble ſalt, which becomes black by being expoſed to the ſun. It has a harſh, ſtrong, metallic taſte. It affords by diſtillation concentrated acid, and leaves behind the ſilver reduced in an arboreſcent form, mixed with a little charcoal, at the bottom of the retort. This ſalt is decompoſed by nitric acid. Its component parts are,

Acid,	36
Oxide of ſulphur,	64
	100

19. Malate of Silver.

2062 Malate. Malic acid added to a ſolution of nitrate of ſilver, produces a precipitate, the nature of which is unknown.

20. Benzoate of Silver.

2063 Benzoate. Benzoic acid combines with the oxide of ſilver, and forms with it a ſalt which is ſoluble in water, is not deliqueſcent in the air, but becomes brown by expoſure to the ſun's rays, and is decompoſed by heat; the acid being driven off, and the oxide reduced to the metallic ſtate.

21. Succinate of Silver.

2064 Succinate. Succinic acid has no action on ſilver, but it combines

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* *Ann. de Chim.* xxxiii 36.

with its oxide. The ſuccinate of ſilver cryſtallizes in thin oblong priſms, which are arranged in a radiated form.

22. Saccolate of Silver.

2065 Saccolate. Saclactic acid poured into a ſolution of nitrate of ſilver produces a white precipitate, the nature of which has not been examined.

II. Action of Alkalies, &c. upon Silver.

2066 Action of ammonia on ſilver. 1. The pure alkalies have no effect on ſilver. Its oxide is ſoluble in ammonia; but if this ſolution be long expoſed to the light, the ammonia is decompoſed, azotic gas is diſengaged, water is formed by the combination of the hydrogen of the ammonia and the oxygen of the oxide, which is reduced to the metallic ſtate.

2. Silver forms no compound with the earths; but in the ſtate of oxide it combines with ſome of them, by vitrification, and in this ſtate it colours glaſs and enamels of a yellow, olive green, or browniſh ſhade. For this purpoſe the oxide of ſilver is employed in the arts.

3. None of the ſalts have any action on ſilver. It is not ſenſibly oxidated by the nitrates or hyperoxymuriates. The metals which are more eaſily oxidated, and with which ſilver is frequently contaminated, are acted on by theſe ſaline matters, and in this way it has been obſerved, ſilver may be refined or purified by means of nitre.

III. Alloys.

1. There are few metallic ſubſtances with which ſilver does not enter into combination, and form alloys. Few of theſe, however, are applied to uſeful purpoſes. Arſenic combines with ſilver, and forms an alloy, which is externally of a yellow colour, but internally of a dark gray. It is brittle; and, when it is expoſed to heat, the arſenic is ſublimed, and the ſilver remains behind in a ſtate of purity.

2067 Cobalt. 2. Cobalt is with difficulty alloyed with ſilver. When they are melted together in a crucible, they ſeparate from each other, according to their ſpecific gravities, and each having a ſmall proportion of the other.

2068 Biſmuth. 3. Biſmuth combines with ſilver very readily by fuſion. The alloy is brittle, lamellated, and of an intermediate colour between biſmuth and antimony. The ſpecific gravity is greater than the mean. The two metals cannot be ſeparated, but with difficulty. When this alloy is expoſed to ſtrong heat in the open air, the biſmuth is oxidated, and vitrified at the ſame time that it is partially ſublimed, ſo that it might be employed in place of lead for the cupellation of ſilver; and in ſome caſes biſmuth is preferred, on account of its more rapid oxidation.

2069 Antimony. 4. The alloy of antimony and ſilver is eaſily effected by fuſion. It is heavier than the mean of the two metals. This alloy is brittle, and has not been applied to any uſe.

2070 Mercury. 5. Silver has a ſtrong affinity for mercury. An amalgam may be formed of theſe two metals, by ſaturating ſilver leaf, or fine filings of ſilver, with mercury; or by adding to ſilver, while it is red-hot, heated mercury. The conſiſtence of this amalgam varies according to the proportion of the two metals. In general it is white and ſoft, and the ſpecific gravity is greater than the mean. It ſinks to the bottom of liquid mercury. Expoſed to a moderate heat for ſome time, it ſhoots out into a kind of vegetation, like the tree of Diana; and, if after fuſion, it is allowed to cool ſlowly, it cryſtallizes in the form of ſmall leaves, or in ſquare priſms, terminated by four-ſided pyramids. When it remains long expoſed to the air, it becomes harder, and of a more ſolid conſiſtence. This amalgam is much employed in gilding.

2071 Zinc. 6. Silver combines readily with zinc, by means of fuſion, and forms with it a brittle alloy, which has not been applied to any uſe.

2072 Tin. 7. Silver combines eaſily with tin, and forms an alloy which is extremely brittle. The ſilver is entirely deprived of its ductility. This alloy, however, inſtead of being uſeful, is conſidered as one of the moſt troubleſome in the working of ſilver, on account of the hardneſs and brittleneſs which it communicates, and it is found almoſt impoſſible to ſeparate them entirely.

2073 Lead. 8. Lead, it has been already obſerved, readily combines with ſilver by means of fuſion. It is employed for the purification of lead in the proceſs of cupellation. This alloy is very fuſible, reſembles lead in colour, and is leſs ſonorous, but not leſs ductile than ſilver. The ſpecific gravity is greater than the mean.

2074 Iron. 9. An alloy of ſilver and iron in equal proportions has nearly the colour of ſilver. It is harder, has ſome ductility, and is attracted by the magnet. Steel is ſoldered with ſilver. Guyton fuſed together ſilver and iron, and obtained two buttons, which were placed by the ſide of each other, and ſtrongly adhering, but ſufficiently diſtinct. Each of the metals was found to be alloyed with a ſmall proportion of the other. The ſilver renders the iron hard and compact, and the iron communicates to the ſilver properties which ſeem to render it applicable to many important uſes.

2075 Copper. 10. Silver combines readily with copper, and forms with it one of the moſt uſeful alloys. This alloy gives hardneſs to the ſilver, and the colour of the latter is not diminiſhed, unleſs the quantity of copper is conſiderable. Theſe properties render it extremely uſeful in the fabrication of various utenſils, and eſpecially of money. The denſity of the alloy is leſs than the mean of the two metals. If 137 parts of ſilver be alloyed with 7 of copper, the mean ſpecific gravity is 10.301, but it is only 10.175, which ſhews an increaſe of bulk of $\frac{1}{81}$ part. This is the alloy of the ſilver coin of France *. The ſtandard ſilver, which is employed in the Britiſh ſilver coin, is compoſed of 11 parts of ſilver and one of copper.

2076 Uſes. The uſes of ſilver are as important and extenſive as any of the metals, except iron, and eſpecially when it is alloyed with copper; as it is applied as the medium of commerce by all civilized nations, and for various inſtruments and utenſils, moſt of which are ſo familiar as to require no particular enumeration.

Sect. XXI. *Of Gold and its Combinations.*

2077 Hiſtory. 1. Gold is ſpoken of in the earlieſt hiſtories of the world. The peculiar properties of this metal, its ſcarcity, durability, and beauty, have rendered it always an object of purſuit, and have raiſed it high in the eſtimation

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* *Jour. de Mines*, N° 30.

tion of mankind. The alchemiſts regarded gold as the pureſt, the ſimpleſt, the moſt perfect, and very juſtly the moſt indeſtructible of all the metals with which they were acquainted. Hence it was eſteemed the nobleſt and moſt perfect of what they conſidered as perfect metals, and dignified with the pompous name of *king of the metals*. It was the object of all their labours and reſearches, to diſcover the means of tranſmuting the baſer and more abundant metals into this precious metal.

2078 Univerſally diffuſed, but in ſmall quantities.

2. Gold is ſuppoſed to be, next to iron, the moſt univerſally diffuſed of all the metals; but, at the ſame time it is found in ſuch ſmall quantities, that it is one of the ſcarceſt. It is moſt commonly found in the ſtate of ſmall grains, mixed with the ſand or with the ſoil, almoſt in every part of the world. Gold is alſo found imbedded in ſtones, eſpecially quartz, either in grains, or cryſtals, which are octahedrons; and it is probably from theſe that the grains found in the ſoil or in the ſand of the beds of rivers, have been derived. Gold is, however, more abundant in the tropical regions of the earth, where it forms an article of commerce, under the name of *gold duſt*. In this ſtate it is found in the rivers of Africa, and exported to Europe. But although gold is always found in the metallic ſtate, it is not abſolutely pure. It is generally alloyed with copper or ſilver, and ſometimes with iron and mercury.

2079 Extraction from its ores.

3. To ſeparate gold from the metals with which it is alloyed, the proceſs recommended by Bergman may be employed. It is firſt diſſolved in nitro-muriatic acid; the ſilver is depoſited ſpontaneouſly in the form of muriate of ſilver, which is inſoluble; the gold is precipitated in fine powder by the ſulphate of iron; the quantity of iron may be aſcertained by pruſſiate of potaſh; and the copper is ſeparated by means of iron. Each of theſe proceſſes is performed on different portions of native gold, ſo that the quantity of gold, and the different metals with which it is alloyed, may be determined. In the large way, the extraction of gold is a very ſimple proceſs. The auriferous ſand of rivers is firſt waſhed to carry off all extraneous matters. It is triturated in a veſſel with water, with 10 or 12 times its weight of mercury. The water is poured off, and carries with it the earthy matters. The amalgam is preſſed in ſkins, to ſeparate the exceſs of mercury, and the ſolid portion which remains is expoſed to heat in ſtone-ware retorts, to drive off the mercury, and the gold remains behind. To ſeparate the gold from other metals, it is ſubjected to the proceſs of cupellation, which has been already deſcribed in treating of the purification of ſilver.

2080 Properties.

4. Gold is of a reddiſh yellow colour. It poſſeſſes conſiderable luſtre, although other metals have this property in a ſuperior degree. Gold, next to platina, is the heavieſt body in nature, having a ſpecific gravity of 19.3 and 19.4. It is not very hard, but is extremely ductile and malleable. It may be beaten out into leaves ſo thin as to equal $\frac{1}{282000}$ part of an inch. The method of extending gold, which is followed by the gold-beaters, is by hammering a number of thin rolled plates between ſkins or animal membranes. A ſingle grain of gold may be beaten out in this way, ſo as to cover 56$\frac{3}{4}$ ſquare inches. The coating of gold, which covers wire, is ſtill thinner. By computation it is found, from the diameter and length of the wire, and the quantity of gold employed, that it is only $\frac{1}{12}$ of the thickneſs of gold leaf. The tenacity of gold alſo is very conſiderable. A gold wire .078 of an inch in diameter will ſupport a weight equal to more than 150 lbs. avoirdupois, without breaking. Gold has no perceptible taſte or ſmell.

2081 Action of heat.

5. Gold melts, according to Guyton, at the temperature of 32° Wedgwood. It has been obſerved, that gold, in the ſtate of filings or grains, melts with more difficulty than in larger maſſes; and that the ſmall fragments, even after they are fuſed, remain in ſeparate globules. To make them run into one maſs, a little nitre or borax is thrown into the crucible. It has alſo been obſerved, that gold, which has only been ſubjected to the degree of heat neceſſary for its fuſion, is brittle after cooling. To preſerve its ductility, therefore, the temperature muſt be raiſed much higher. It is brittle alſo, when it is too ſuddenly cooled after fuſion. By increaſing the temperature while the gold is in fuſion, it ſeems to become convex on the ſurface, and when it cools, it ſinks, which is aſcribed to the expanſion and contraction of the metal. When it is ſlowly cooled, it cryſtallizes in the form of quadrangular pyramids, or regular octahedrons. If the heat be continued while it is in perfect fuſion, it ſeems to be agitated, and to undergo a kind of ebullition. This was obſerved by Homberg and Macquer, by the action of the burning glaſs, or when a ſmall globule of gold was acted on by the blow-pipe. According to Macquer, it roſe in vapour to the height of five or ſix inches, and attached itſelf to the ſurface of a ſilver-plate, which it gilded completely.

2082 Of air.

6. Gold is the moſt indeſtructible, and the leaſt altered of all the metals, by expoſure to the air. It preſerves its luſtre, its brilliancy, and colour, for any length of time.

2083 Oxidation.

7. The ſtrongeſt heat of a furnace, which has been applied to gold in fuſion, has been found incapable of producing the ſmalleſt change, or the leaſt tendency to oxidation; but, by the action of Tſchirnhauſen's powerful burning glaſs, Homberg having placed ſome gold in the focus, found that it roſe in vapour; and that it was covered with a violet-coloured vitreous oxide. This change was at firſt aſcribed to foreign bodies, particularly to the charcoal on which the gold was placed during the experiment. But Macquer repeated the ſame experiments with a more powerful glaſs, and obtained the ſame reſult. The vitrification after ſome time gradually extended, the gold diminiſhed, and the ſupport was impregnated with a purple coloured matter.

2084 By electricity.

The effect of electricity on gold leaf, placed between two cards, was obſerved by Camus in 1773. The gold was converted into a violet-coloured powder, which adhered to the paper. This ſeeming oxidation was regarded by ſome as merely a minute mechanical diviſion of the gold; but this objection has been removed by the experiments of Van Marum on the combuſtibility of gold by means of the powerful electrical machine at Haerlem. A ſtrong electrical ſhock was paſſed through a golden wire ſuſpended in the air. It kindled, burned with a perceptible green flame, and was reduced to fine powder, which was diſſipated in the air. It was ſuppoſed by this philoſopher, that the inflammation of gold might be effected without the exceſs of oxygen gas, as he found it to take place in hydrogen gas and other elaſtic fluids, which are incapable of ſupporting combuſtion. But the force of this objection is removed by recollecting, that all gaſes hold in ſolution a quantity of water, and that water is very readily decompoſed by electricity.

2085 By lightning. A ſimilar oxidation has been obſerved to take place on the gilding in the inſide of houſes, or on the furniture, which has been ſtruck with lightning. The purple oxide of gold thus obtained, contains about five or ſix parts in the hundred of oxygen. Gold combines with a greater proportion of oxygen, forming a different oxide of a yellow colour, but this oxide is incapable of combining with any farther portion of oxygen. It remains, therefore, unchanged in the air, and retains for a long time its brilliant rich colour. This oxide, however, is decompoſed by the action of heat; the oxygen is driven off, and the gold remains behind in the metallic ſtate.

2086 Yellow oxide. When gold is diſſolved in nitro-muriatic acid, or in a mixture of equal parts of nitric and muriatic acids, an effervescence takes place, and the ſolution becomes of a yellow colour. In this proceſs the nitric acid is decompoſed, its oxygen combines with the gold, and the oxide, as it is formed, is diſſolved in the muriatic acid. By adding lime water, a precipitate is formed, which is the yellow oxide of gold, conſiſting of eight or ten parts of oxygen in the 100.

8. There is no action between gold and azote, hydrogen, carbone or ſulphur. The oxides of gold, indeed, are readily decompoſed by hydrogen.

2087 Phoſphuret. 9. Phoſphorus, according to the experiments of Pelletier, combines with gold, by heating together in a crucible a mixture of one part of gold in filings, with two parts of phoſphoric glaſs, and one-eighth part of charcoal. Great part of the phoſphorus is ſeparated from the acid, and driven off, but there remains a ſmall quantity united with the gold, forming a phoſphuret of gold. This phoſphuret is whiter and more brittle than the gold, and has ſome appearance of cryſtallization. It may be formed alſo by adding phoſphorus to gold in a red heat in a crucible It becomes pale coloured, granulated, brittle, and a little more fuſible. This phoſphuret contains $\frac{1}{24}$ part of phoſphorus. It is decompoſed by being kept ſome time in fuſion; the phoſphorus is driven off in the ſtate of vapour, and inflamed.

2088 Affinities. 10. The order of the affinities of gold and its oxides, as they have been arranged by Bergman, is the following:

Gold.	Oxide of Gold.
Mercury,	Muriatic acid,
Copper,	Nitric,
Silver,	Sulphuric,
Lead,	Arſenic,
Biſmuth,	Fluoric,
Tin,	Tartaric,
Antimony,	Phoſphoric,
Iron,	Pruſſic.
Platina,	
Zinc,	
Nickel,	
Arſenic,	
Cobalt,	
Mangeneſe.	

II. Salts of Gold.

1. Nitrate of Gold.

2089 Preparation. When concentrated nitric acid is ſeveral times ſucceſſively poured upon gold, boiled and diſtilled to dryneſs, the gold is diſſolved, and the ſolution aſſumes a yellow colour. This effect was firſt obſerved by Brandt, in ſeparating gold and ſilver, by means of this acid. But it appears from the obſervation of Deyeux on the ſolubility of gold in nitric acid, that the ſolution is more readily effected in proportion to the quantity of gas, or nitrous gas, which the acid contains. According to the experiments and obſervations of Fourcroy, gold leaf is diſſolved in nitric acid, impregnated with nitrous oxide, and that it is owing to the nitrous oxide that the gold is oxidated, this oxide being more eaſily decompoſed than nitric acid. Thus it happens that the acid is deprived of its colour as it acts on the gold, and the ſolution is more rapidly effected in the cold than with heat, becauſe the nitrous gas is diſengaged by heat. The acid which at firſt had been deprived of its colour, by the oxidation of the gold, as this oxide is diſſolved, aſſumes an orange-yellow colour, holding in ſolution the nitrate of gold with exceſs of acid. The nitrate of gold cannot be obtained in cryſtals. 2090 Decompoſed by heat and the alkalies. It is decompoſed by heat, or by expoſure to the light of the ſun. When this ſolution is filtered, it leaves on the paper a violet-coloured trace, which is the oxide of gold. The nitrate of gold is alſo decompoſed by the alkalies, or by introducing a plate of tin or ſilver into the ſolution, and the purple oxide is precipitated in the form of powder. It is alſo decompoſed by muriatic acid, which, at the inſtant of combination, converts the orange colour to a pure yellow.

2. Muriate of Gold.

2091 Preparation. 1. Muriatic acid has no action whatever on gold, or on its purple oxide, but gold is immediately oxidated and diſſolved by oxymuriatic acid; or if nitric acid be added to muriatic acid, the ſolution of gold is immediately effected. It is on account of this property that nitro-muriatic acid was diſtinguiſhed by the name of *aqua regia*, becauſe it diſſolved gold, which was ſtiled by the alchemiſts, the *king of the metals*. The nature of this action is obvious. Gold is oxidated with great difficulty. This is effected by oxymuriatic acid, which readily parts with its oxygen, or by the addition of nitric to the muriatic acid, the former of which is decompoſed, giving up its oxygen to the gold, which being oxidated, is diſſolved in the muriatic acid, forming a muriate of gold. 2092 Properties. This ſolution of the muriate of gold is of a deep yellow colour, extremely acrid and cauſtic, has a very aſtringent, metallic taſte, and ſtains the ſkin of a deep purple colour, which becomes darker by expoſure to the air and the light. It continues permanent till the epidermis is renewed. It produces a ſimilar effect on all vegetable and animal matters, and on marble and ſiliceous ſtones. By evaporating this ſolution, nitric acid is diſengaged, and cryſtals are obtained, in the form of truncated octahedrons, or ſmall quadrangular priſms, of a topaz colour. Theſe cryſtals are eaſily procured by evaporating the ſolution to one half, and adding a little alcohol. They aſſume a red colour by the action of ſtrong light. They attract moiſture from the air, and ſpontaneouſly become liquid. By gradually heating in a retort this ſolution of gold in nitro-muriatic acid, there paſſes over nitric acid, muriatic acid, which carries with it a portion of gold, and even reddiſh-yellow cryſtals of muriate of gold. To the nitro-muriatic liquid, which is of a high colour, and which riſes during the diſtillation, the alchemiſts gave the name of *red lion*. By evaporating the ſolution to dryneſs, a dry muriate of gold is obtained, which may be reduced by a ſtrong heat, previouſly giving out oxygen gas, and leaving the gold behind in the metallic ſtate.

2093 Decompoſition. 2. The muriate of gold is very ſoluble in water. It is decompoſed by hydrogen gas. 2094 By hydrogen. If a piece of ſilk be moiſtened with a ſolution of muriate of gold, the ſalt is decompoſed, and the gold, reduced to the metallic ſtate, attaches itſelf to the ſilk. 2095 Phoſphorus. Muriate of gold is alſo decompoſed by phoſphorus. If a ſtick of phoſphorus be introduced into a ſaturated ſolution of muriate of gold, the ſalt is decompoſed, and the gold being reduced to the metallic ſtate, forms a cylindrical covering to the phoſphorus, which may be ſeparated by diſſolving the latter in hot water. A ſimilar effect is produced by burning ſulphur, by ſulphurated and phoſphorated hydrogen gaſes, and by ſulphurous acid. 2096 Sulphurous acid. If a ſolution of muriate of gold be cautiouſly added to ſulphurous acid, a fine pellicle of gold appears on the ſurface, which is inſtantly precipitated in the form of ſmall grains. Theſe curious and intereſting experiments were made by Mrs Fulham. It is eaſy to ſee the nature of the proceſs. All the ſubſtances which have been enumerated, have a ſtronger affinity for oxygen than gold, ſo that the oxide of gold in combination with the acid is decompoſed; the oxygen combining with the hydrogen, for inſtance, and forming water, or with the phoſphorus or ſulphur, and forming ſulphuric or phoſphoric acid. The reduction of muriate of gold, Mrs Fulham has obſerved, does not take place except in the liquid ſtate, and ſhe ſuppoſes that the decompoſition of water is neceſſary to produce this effect. But the liquid ſtate of the ſalt, it is ſuppoſed by others, is only neceſſary, to expoſe it to the action of combuſtibles in a ſtate of minute diviſion, and that otherwiſe this theory does not account for the phenomena.

2097 Soluble in ether. 3. The muriate of gold is ſoluble in ether. It forms with it a ſolution of a golden yellow colour, which floats on the top of the fluid. By adding ether to a ſolution of gold, and agitating the mixture, as ſoon as it is left at reſt, the two liquids ſeparate, the ether riſes to the top, and aſſumes a yellow colour, while the nitro-muriatic acid remains below and becomes white. By this proceſs a tincture of gold, or what was formerly called *potable gold*, was prepared. The ſolution of gold in ether is not permanent. It is ſoon reduced to the metallic ſtate, and is ſometimes found cryſtallized on the ſurface.

2098 Action of alkalies. 4. The muriate of gold is decompoſed by all the alkalies and earths, and is reduced to the ſtate of yellow oxide. This decompoſition is effected ſlowly by the fixed alkalies, and if the alkali be added in ſufficient quantity, the precipitate is re-diſſolved, and the liquid aſſumes a reddiſh colour. It is owing to this ſolution of the oxide of gold by theſe alkalies, that the precipitation is ſlow and difficult. Triple ſalts are formed, the nature of which is unknown. The oxide of gold thus precipitated, becomes of a purple colour by expoſure to the light; by the action of heat it gives out oxygen gas, and the gold is revived.

2099 Fulminating gold. The moſt ſingular precipitate from the muriate of gold, is that by means of ammonia, which forms the compound called *fulminating gold*. It is prepared by the following proceſs. To a ſolution of gold in nitro-muriatic acid, and diluted with three or four times its weight of diſtilled water, gradually add pure ammonia, as long as any precipitate is formed. No exceſs of alkali muſt be added, becauſe the precipitate is rediſſolved. It is then waſhed and dried in the air on paper, and afterwards put into a phial, which ſhould be covered only with a bit of cloth or paper, as the powder is apt to explode with the ſlighteſt friction.

2100 Another proceſs. Fulminating powder may alſo be obtained, by diſſolving gold in a ſolution of two parts of nitrate of ammonia, and one of muriatic acid. The oxygen of the nitric acid combines with the gold, and forms an oxide, which is diſſolved in a portion of the muriatic acid; nitrous gas is diſengaged, and there remain in the liquid, muriate of gold, and muriate of ammonia. By precipitating this ſolution by means of a fixed alkali, fulminating gold is obtained. The alkali combines with the muriatic acid of the gold and ammonia, and the oxide of gold uniting with the ammonia, forms the fulminating gold. The precipitate is waſhed and dried as in the former proceſs. Baſil Valentine, who firſt deſcribed this ſingular preparation, had obſerved that it produced detonation equally by means of heat, by friction, and percuſſion. When a ſmall quantity of fulminating powder is expoſed to heat, it produces a violent detonation; or, if it be rubbed with a hard body, a ſimilar effect takes place. It explodes alſo, by being ſmartly ſtruck with a hammer. Theſe aſtoniſhing effects long excited the attention of philoſophers, but received no ſatisfactory explanation, till the nature of the compoſition of this ſubſtance was diſcovered by modern chemiſts. It was examined by Scheele and Bergman; and at laſt the theory of its violent action was fully developed by Berthollet. This compound conſiſts of the oxide of gold and ammonia, and as the oxide performs the part of an acid, it is ſometimes denominated *aurate of ammonia*. 2101 Theory. During the exploſion which takes place, whether by the application of heat, or by friction or percuſſion, the hydrogen of the ammonia combines with the oxygen of the oxide of gold, and forms water. This water being ſuddenly raiſed to the ſtate of vapour, and the azote, the other component part of ammonia, being at the ſame time ſuddenly converted into gas, produce the exploſion. The gold is reduced to the metallic ſtate.

2102 May be decompoſed without exploſion. This ſubſtance may be deprived of its fulminating property, by being expoſed for ſome time to a very gentle heat. It is then converted into a blackiſh brown powder. A ſimilar effect is produced, by ſubjecting it for a long time to the temperature of boiling water. Its fulminating property is at leaſt greatly diminiſhed by the latter proceſs. It appears too, that the contact of air promotes this action; for when it was heated in an iron globe, in an experiment which Birch performed before the Royal Society of London, or in a ſphere of ſtrong copper, in an experiment by Bergman, no detonation took place. Berthollet applied a gentle heat to a quantity of fulminating gold, in copper tubes; and he obtained ammoniacal gas, and the gold was reduced to the ſtate of purple oxide. By theſe experiments it appears, that this ſubſtance is decompoſed without detonation, when the ſudden dilatation of the gaſes which are diſengaged is reſiſted by ſtrong veſſels, or when the heat is ſo moderate as to ſeparate the ammonia without decompoſition.

2103 Action of metals. 5. The muriate of gold is decompoſed by almoſt all metallic ſubſtances. Some metals decompoſe it completely, and reduce it to the metallic ſtate, while others deprive it of a portion of oxygen, and reduce it to the ſtate of purple oxide. Biſmuth, zinc, iron, copper, and mercury, reduce the gold to the metallic ſtate. Lead, ſilver, and tin, occaſion a precipitate in the form of purple oxide. The moſt ſingular of all theſe precipitates, and which has long occupied the attention of chemiſts, is that which is produced by means of tin. 2104 Purple powder of Caſſius. This is called the *purple precipitate*, or *powder of Caſſius*. It was at firſt particularly deſcribed by Caſſius, from whom it derived its name; but it was known long before, even ſo early as the time of Baſil Valentine, by whom it is mentioned. If a plate of tin be immerſed in a ſolution of muriate of gold, the ſurface of the metal is ſoon covered with a deep-coloured violet or purple powder, which is gradually diffuſed through the whole liquid. This is uſually prepared by adding to a ſolution of gold in nitro-muriatic acid, a ſolution of muriate of tin recently prepared. The theory of this proceſs is the following. The gold in ſolution is in the ſtate of yellow oxide. It is deprived of part of its oxygen, and reduced to the ſtate of purple oxide by the tin. The purple oxide is no longer ſoluble in the acid, and is therefore precipitated. The ſame effect is produced when a ſalt of tin is added, provided this ſalt be not fully ſaturated with oxygen, for in that caſe no precipitate is obtained. This is the reaſon, as Pelletier has ſhown, that muriate of tin, after it has been for ſome time expoſed to the air, loſes the property of producing the purple precipitate, becauſe it has abſorbed oxygen from the atmoſphere, and is not ſuſceptible of combining with a greater quantity. For the ſame reaſon no precipitate is obtained by the oxymuriate of tin, or the *ſmoking liquor of Libavius*, or the red ſulphate of iron, becauſe both theſe ſalts have their baſes fully ſaturated with oxygen. Other metallic ſolutions have alſo the property of decompoſing and precipitating the muriate of gold. The nitrate of ſilver produces a reddiſh precipitate, which is a mixture of white muriate of ſilver and purple oxide of gold. The nitrate of lead depoſits a dark coloured ſubſtance, compoſed of muriate of lead and oxide of gold.

2105 Metallic acids. 6. The metallic acids have no effect whatever on gold. Vauquelin found that chromic acid, mixed with muriatic acid, gave it the property of diſſolving gold. This is owing to the chromic acid giving up part of its oxygen, which appears to be the caſe, from its paſſing from its natural colour, which is orange, to the ſtate of green oxide.

II. Action of Alkalies, &c. upon Gold.

2106 Alkalies. 1. None of the alkalies have any action upon gold, or on its purple oxide, but the yellow oxide precipitated from its ſolution by means of the fixed alkalies, and digeſted for ſome time with ammonia, is readily converted into fulminating gold.

2107 Earths. 2. The earths have no action on gold in the metallic ſtate; but in the ſtate of purple or yellow oxide, it combines with the earths which are vitrified by means of the alkalies, and forms with them enamels, which are of a violet or purple colour, or glaſs of a golden-yellow colour. It is on account of the latter property that the yellow oxide is employed in the fabrication of artificial topazes. It has been obſerved that glaſs coloured by means of gold, and which contains a conſiderable proportion of oxide of lead or of mangancſe, has a remarkable property of changing to a permanent purple or ruby-red colour, when it is ſlightly heated, and long before fuſion. This is ſuppoſed to be owing to ſome change in the ſtate of the oxidation of the different metals.

2108 Salts. 3. The moſt powerful ſalts, as the nitrates, the hyperoxymuriates, have no action on pure gold. It has, however, been obſerved, that borax diminiſhes its colour, and that nitre, which is employed in its purification, renders it more brilliant.

III. Alloys of Gold.

2109 With arſenic. 1. Gold is ſuſceptible of combination with moſt metallic ſubſtances, which produce a very particular change on its properties. The alloy with arſenic is brittle, hard, of a granulated texture, and of a very pale colour. According to Mr Hatchett's experiments, arſenic readily combines with gold raiſed to a common red heat, when the former is in the ſtate of vapour, and particularly when the combination is made in cloſe veſſels.

2110 Tungſten, &c. 2. The alloys of gold with tungſten, molybdena, chromium, titanium, and uranium, have not been examined.

2111 Cobalt. 3. The combination of gold and cobalt is not perceptibly different from pure cobalt. This alloy reduced to a fine powder, and heated in contact with air, gives, after its oxidation, and by ſtrong heat, a deep blue glaſs. In Mr Hatchett's experiments, one part of cobalt and 14 of gold form a brittle alloy of a dull yellow colour. With $\frac{1}{65}$ of cobalt the alloy was brittle, but became ductile with $\frac{1}{130}$ part.

2112 Nickel. 4. Gold forms with nickel a white and brittle alloy. In Mr Hatchett's experiments $\frac{1}{28}$ of nickel rendered the alloy brittle. It was ſcarcely, if at all, brittle with $\frac{1}{65}$ part, and with $\frac{1}{130}$ of nickel it was completely ductile. One part of nickel and 16 of gold give an alloy of the colour of braſs.

5. Mr Hatchett formed an alloy of gold with mangancſe. It was of a pale yellowiſh-gray colour, had ſomething of the luſtre of poliſhed ſteel, and ſome ductility, although it was very hard. It contained about one-ninth of mangancſe. Acids produced no effect, nor was it altered by expoſure to the air*.

2113 Biſmuth. 6. Biſmuth fuſed with gold, yields an alloy which is brittle in proportion to the quantity of biſmuth employed. The ſpecific gravity of this alloy is greater than the mean. In Mr Hatchett's experiments, this alloy was brittle, when the proportion of biſmuth amounted only to $\frac{1}{1920}$ part.

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* Phil. Trans. 1803.

2114 Antimony. 7. Antimony combines with gold, and renders it hard and brittle. Equal parts of theſe metals form an alloy not much different in appearance from gold itſelf. This compound was frequently employed by the alchemiſts in their reſearches. Antimony was called the *royal bath*. They pretended that the quantity of gold was increaſed when it was ſeparated from the alloy, after having been fuſed with this metal. But it appears that this increaſe of weight was owing to part of the antimony, which was not ſeparated from the gold. The ſulphuret of antimony was formerly much employed for the purification of gold, to ſeparate by means of the ſulphur, the metals which were combined with it; and from this property of acting on all the metals then known, excepting gold, the ſulphuret of antimony was called by the alchemiſts, *the wolf of the metals*.

2115 Mercury. 8. Gold unites very readily with mercury. If gold be brought into contact with this metal, it is inſtantly covered with it; and if gold leaf be triturated with mercury, it totally diſappears, and is diſſolved in the mercury; ſo that even in the cold, mercury combines with the whole quantity of gold with which it can be alloyed. When the proportion of gold is increaſed, the amalgam becomes ſolid. When this operation is performed in the large way, the combination is promoted by means of moderate heat. This amalgam is of a yellowiſh white colour; it is fuſible at a moderate heat, and cryſtallizes in the form of quadrangular priſms. It is decompoſed by a ſtrong heat, and the mercury is diſſipated. This amalgam is much employed in gilding.

2116 Zinc. 9. Gold combines with zinc by means of fuſion. This alloy is paler than gold, has little malleability, and if the proportion of the zinc be conſiderable, is very brittle. An alloy conſiſting of equal parts of the two metals, is of a greater ſpecific gravity than the mean, is very hard, ſuſceptible of a fine poliſh, and is not much altered by the air. It has been recommended, on account of theſe properties, for the fabrication of the mirrors of teleſcopes.

2117 Tin. 10. Gold combines eaſily with tin by means of fuſion. This alloy, it is ſaid, is the dread of the workmen, becauſe it deprives gold of its ductility. They are even cautious in preſerving gold from the contact of the vapour of tin in fuſion, which renders the gold ſo brittle, that it may be reduced to powder in a mortar. It is extremely difficult to purify gold after it has been alloyed with tin, for it does not paſs into the cupel with lead or with biſmuth. Nitre, borax, and even the hyperoxymuriate of mercury, which are often employed with this view, do not always ſucceed. The moſt ſucceſsful method is by treating the alloy with ſulphuret of antimony, or with muriatic acid, which diſſolves the tin when it is in conſiderable proportion. But in the experiments of Mr Hatchett and Mr Bingley, it appears that the univerſal opinion which has hitherto prevailed, of tin being ſo injurious to the ductility of gold, is to a certain extent, erroneous; and it appears probable, that the ductility of gold being deſtroyed, as was ſuppoſed, even by the fumes of tin, ought to have been aſcribed to other metals, as biſmuth, lead, antimony, or zinc, with which the tin was contaminated.

2118 Lead. 11. Lead very readily combines with gold by fuſion; this alloy deprives the gold of its ductility, and diminiſhes the colour. So ſmall a proportion as $\frac{1}{1920}$ part of lead deſtroys the ductility of gold. This alloy, it has been already ſtated, is made for the purpoſe of purifying gold from other metals, in conſequence of the eaſy oxidation and vitrification of the lead.

2119 Iron. 12. Gold is eaſily alloyed with iron, and forms with it a hard brittle maſs. Some of theſe alloys are ſo hard, that Dr Lewis found them fit for cutting inſtruments. Equal parts of iron and gold form an alloy of a gray colour. Four parts of iron and one of gold afford an alloy nearly of the colour of ſilver, and the ſpecific gravity of this alloy has been aſcertained to be leſs than the mean. One part of iron alloyed with 12 of gold, according to Mr Hatchett, was of a pale-yellowiſh gray colour, and was ſo ductile that it might be rolled and cut. When gold is fuſed, it adheres readily to iron; and hence it has been propoſed to ſolder ſmall pieces of ſteel with gold, which ſeems to be preferable to copper.

2120 Copper. 13. Gold readily combines with copper by fuſion. This is one of the moſt important alloys, on account of the hardneſs which copper communicates to gold, without diminiſhing its colour. This alloy, according to Muſchenbroeck, poſſeſſes the greateſt hardneſs, without ſenſibly diminiſhing its ductility, when the proportions are one part of copper and ſeven of gold. This alloy is more fuſible than gold, and on that account it is employed as a ſolder for that metal. The gold coin of moſt countries conſiſts of this alloy. The proportions in the gold coin of Britain and France are 11 parts of gold to one of copper. According to Briſſon, the ſpecific gravity of this alloy is greater than the mean. It is 17.486, but it ought to be 17.153. But, according to Mr Hatchett's experiments, there is no mutual penetration in the alloy of theſe metals, and therefore no increaſe of denſity. On the contrary, ſome degree of expanſion was obſerved. Four hundred and forty-two grains of gold of ſpecific gravity 19.172, were alloyed with 38 grains of copper of ſpecific gravity 8.875. The ſpecific gravity of the alloy was found to be 17.157. The bulk of the alloyed maſs amounted to 27.98, while the natural bulk of the two metals before combination was 27.32, which ſhews an increaſe of expanſion of the alloyed maſs equal to $\frac{66}{100}$. Mr Hatchett obſerves that Briſſon's experiment was probably made on part of a large bar or ingot, in which it generally happens, that the two metals are very unequally diffuſed, and this inequality, which is greater according to the quantity of the metal, is found to vary with the form, nature, and poſition of the mould, and therefore to produce variations in the ſpecific gravity*.

2121 Silver. 14. Silver forms an alloy with gold. Homberg found, that equal parts of theſe metals fuſed together in a crucible, formed an alloy which contained $\frac{1}{7}$ of its weight of ſilver. One part of ſilver and two of gold, according to Muſchenbroeck, give to the alloy the greateſt degree of hardneſs. One-twentieth part of ſilver changes the colour of gold very ſenſibly. This alloy is employed for ſoldering gold, being more fuſible than this metal.

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* *Phil. Trans.* 1803, p. 112.

15. Mr Hatchett obſerves, that the obvious inference to be deduced from his experiments is, that only two metals are proper for the alloy of gold coin. Theſe are, ſilver and copper. All other metals either conſiderably alter the colour, or diminiſh the ductility of gold. According to the ſame philoſopher, the ductility of gold is diminiſhed by different metallic ſubſtances, nearly in the following decreaſing order:

Biſmuth, } Theſe are nearly equal in effect.
Lead, }
Antimony, }
Arſenic,
Zinc,
Cobalt,
Mangeneſe,
Nickel,
Tin,
Iron,
Platina (E),
Copper,
Silver *.

* *Phil. Trans.* 1803, 95. 112

Uſes.

The uſes of gold, many of which have been already detailed, in deſcribing its properties and combinations, are too familiar to require particular enumeration (F).

SECT.

(E) Mr Hatchett ſuppoſes that the platina not being quite pure, the place he has aſſigned to it is perhaps not preciſely that which it ought to occupy.

(F) The metals which were earlieſt known, were long diſtinguiſhed by particular names and characters, of which the following account is taken from the elaborate reſearches of Profeſſor Beckmann. The following table exhibits their names and characters.

Metals.	Names.	Characters.
Gold,	Sun,	☉
Silver,	Moon,	☽
Mercury,	Mercury,	☿
Copper,	Venus,	♀
Iron,	Mars,	♂
Tin,	Jupiter,	♃
Lead,	Saturn,	♄

It cannot be doubted, Profeſſor Beckmann obſerves, that theſe names were firſt given to to the heavenly bodies; and the metals which were then known, amounting to the ſame number, were ſuppoſed to have ſome affinity or relationſhip to the planets, and with them to the gods, and were accordingly named after them. "To each god was aſſigned a metal, the origin and uſe of which was under his particular providence and government; and to each metal were aſcribed the powers and properties of the planet and divinity of the like name; from which aroſe, in the courſe of time, many of the ridiculous conceits of the alchemiſts.

"The oldeſt trace of the diviſion of the metals among the gods is to be found, as far as I know, in the religious worſhip of the Perſians. Origen, in his refutation of Celſus, who aſſerted that the ſeven heavens of the Chriſtians, as well as the ladder which Jacob ſaw in his dream, had been borrowed from the myſteries of Mithras, ſays, 'Among the Perſians the revolutions of the heavenly bodies were repreſented by ſeven ſtairs, which conducted to the ſame number of gates. The firſt gate was of lead; the ſecond of tin; the third of copper; the fourth of iron; the fifth of a mixed metal; the ſixth of ſilver, and the ſeventh of gold. The leaden gate had the ſlow tedious motion of Saturn; the tin gate the luſtre and gentleneſs of Venus; the third was dedicated to Jupiter; the fourth to Mercury, on account of his ſtrength and fitneſs for trade; the fifth to Mars; the ſixth to the Moon, and the laſt to the Sun.' 'Celſus de quibuſdam Perſarum myſteriis ſermonem facit. Harum rerum, inquit, aliquod reperitur in Perſarum doctrina Mithraciſque eorum myſteriis veſtigium. In illis enim duæ cæleſtes converſiones, alia ſtellarum fixarum, errantium alia, et animæ per eas tranſitus quodam ſymbolo repræſentantur, quod hujuſmodi eſt. Scala altas portas habens, in ſumma autem octava porta. Prima portarum plumbea, altera ſtannea, tertia ex ære, quarta ferrea, quinta ex ære mixto, ſexta argentea, ſeptima ex auro. Κλιμαξ ὑψιπυλος, ἐπι δ᾽αυτῃ πυλη ὀγδοη. Ἡ πρωτη των πυλων μολιβδου, ἡ δευτερα κασσιτερου, ἡ τριτη χαλκου, ἡ τεταρτη σιδηρου, ἡ πεμπτη κεραςου νομισματος, ἡ ἑκτη αργυρου, χρυσου δ᾽ ἡ ἑβδομη. Primum aſſignant Saturno tarditatem illius ſideris plumbo indicantes: alteram Veneri, quam referunt, ut ipſi quidem putant, ſtanni ſplendor et mollities; tertiam Jovi, aheneam illam quidem et ſolidam: quartam Mercurio, quia Mercurius et ferrum, uterque operum omnium tolerantes, ad mercaturam utiles, laborum patientiſſimi. Marti quintam, inæqualem illam et variam propter mixturam. Sextam, que argentea eſt, lunæ; ſeptimam auream ſoli tribuunt, quia ſolis et lunæ colores hæc duo metalla referunt.' *Contra Celſum*, lib. vi. 22. p. 161. Here then is an evident trace of metallurgic aſtronomy, as Borrichius calls it, or of the aſtronomical or mythological nomination of metals, though it differs from that uſed at preſent. According to this arrangement, tin belonged to Jupiter, copper to Venus, iron to Mars, and the mixed metal to Mercury. The conjecture of Borrichius, that the tranſcribers of Origen have, either through ignorance or deſign, tranſpoſed the names of the gods, is highly probable: for if we reflect that in this nomination men, at firſt, differed as much as in the nomination of the planets, and that the names given them were only confirmed in the courſe of time, of which I ſhall ſoon produce proofs, it muſt be allowed that the cauſes aſſigned by Origen for his nomination do not well agree

with

SECT. XXII. *Of Platina and its Combinations.*

2123 History.

Platina in moſt of its properties is equal to gold, but in others, it is ſuperior. It was firſt clearly aſcertained to be a diſtinct metal, by Scheffer, a Swediſh chemiſt, in the year 1752. It had been indeed taken notice of at an earlier period. A quantity of it was brought from Jamaica in 1741, by Mr Wood. It is particularly mentioned by Antonio de Ulloa, a Spaniſh mathematician, in the account of his voyage to Peru with the French academicians, to meaſure a degree of the meridian, which was publiſhed in 1748. After this period numerous experiments were made upon this new ſubſtance, all of which tended to prove that it is a different metal from any formerly known; Scheffer

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with the preſent reading, and that they appear much juſter when the names are diſpoſed in the ſame manner as that in which we now uſe them. Borrichius arranges the words in the following manner: Secundam portam faciunt Jovis, comparantes ei ſtanni ſplendorem et mollitiem; tertiam Veneris æratam et ſolidam; quartam Martis, eſt enim laborum patiens, æque ac ferrum, celebratus hominibus; quintam Mercurii propter miſturam inæqualem ac variam, et quia negotiator eſt; ſextam Lunæ argenteam: ſeptimam Solis auream. *Ol. Borrichius de ortu et progreſſu chemiæ.* Hafniæ 1668, 4to. p. 29.

"This aſtrological nomination of metals appears to have been conveyed to the Brachmans in India; for we are informed that a Brachman ſent to Apollonius ſeven rings, diſtinguiſhed by the names of the ſeven ſtars or planets, one of which he was to wear daily on his finger, according to the day of the week. This can be no otherwiſe explained than by ſuppoſing that he was to wear the gold ring on Sunday; the ſilver one on Monday; the iron one on Tueſday, and ſo of the reſt. Alluſion to this nomination of the metals after the gods occurs here and there in the ancients. Dydimus, in his Explanation of the Iliad, calls the planet Mars the iron ſtar. Thoſe who dream of having had any thing to do with Mars are by Artemidorus threatened with a chirurgical operation; for this reaſon, he adds, becauſe Mars ſignifies iron. Heraclides ſays alſo in his allegories, that Mars was very properly conſidered as iron; and we are told by Pindar that gold is dedicated to the ſun.

"Plato likewiſe, who ſtudied in Egypt, ſeems to have admitted this nomination and meaning of the metals. We are at leaſt aſſured ſo by Marſilius Ficinus; but I have been able to find no proof of it, except where he ſays of the iſland Atlantis, that the exterior walls were covered with copper and the interior with tin, and that the walls of the citadel were of gold. It is not improbable that Plato adopted this Perſian or Egyptian repreſentation, as he aſſigned the planets to the demons; but perhaps it was firſt introduced into his ſyſtem only by his diſciples. They ſeem, however, to have varied from the nomination uſed at preſent: as they dedicated to Venus copper, or braſs, the principal component part of which is indeed copper; to Mercury tin, and to Jupiter electrum. The laſt-mentioned metal was a mixture of gold and ſilver; and on this account was probably conſidered to be a diſtinct metal, becauſe in the early periods mankind were unacquainted with the art of ſeparating theſe noble metals.

"The characters by which the planets and metals are generally expreſſed when one does not chooſe to write their names, afford a ſtriking example how readily the mind may be induced to ſuppoſe a connection between things which in reality have no affinity or relation to each other. Antiquaries and aſtrologers, according to whoſe opinion the planets were firſt diſtinguiſhed by theſe characters, conſider them as the attributes of the deities of the ſame name. The circle in the earlieſt periods among the Egyptians was the ſymbol of divinity and perfection; and ſeems with great propriety to have been choſen by them as the character of the ſun, eſpecially as, when ſurrounded by ſmall ſtrokes projecting from its circumference, it may form ſome repreſentation of the emiſſion of rays. The ſemicircle is, in like manner, the image of the moon, the only one of the heavenly bodies that appears under that form to the naked eye. The character ♄ is ſuppoſed to repreſent the ſcythe of Saturn; ♃ the thunderbolts of Jupiter; ♂ the lance of Mars, together with his ſhield; ♀ the looking-glaſs of Venus; and ☿ the caduceus or wand of Mercury.

"The expreſſion by characters adopted among the chemiſts agrees with this mythological ſignification only in the character aſſigned to gold.—Gold, according to the chemiſts, was the moſt perfect of metals, to which all others ſeemed to be inferior in different degrees. Silver approached neareſt to it; but was diſtinguiſhed only by a ſemicircle, which, for the more perſpicuity, was drawn double, and thence had a greater reſemblance to the moſt remarkable appearance of the moon; the name of which this metal had already obtained. All the other metals, as they ſeemed to have a greater or leſs affinity to gold or ſilver, were diſtinguiſhed by characters compoſed of the characters aſſigned to theſe precious metals. In the character ☿ the adepts diſcover gold with a ſilver colour. The croſs placed at the bottom, which among the Egyptain hieroglyphics had a myſterious ſignification, expreſſes, in their opinion, ſomething I know not what, without which quickſilver would be ſilver or gold. This ſomething is combined alſo with copper, the poſſible change of which into gold is expreſſed by the character ♀. The character ♂ declares the like honourable affinity alſo; though the ſemicircle is applied in a more concealed manner; for, according to the propereſt mode of writing, the point is wanting at top, or the upright line ought only to touch the horizontal, and not to interſect it. Philoſophical gold is concealed in ſteel; and on this account it produces ſuch valuable medicines. Of tin one half is ſilver, and the other conſiſts of the ſomething unknown: for this reaſon the croſs with the half moon appears in ♃. In lead this ſomething is predominant, and a ſimilitude is obſerved in it to ſilver. Hence in its character ♄ the croſs ſtands at the top, and the ſilver character is only ſuſpended on the right hand behind it.

"The mythological ſignification of theſe characters cannot be older than the Grecian mythology; but the chemical

Scheffer gave it the name of *white gold*, becauſe it reſembled this metal in many of its properties. In the year 1754, Dr Lewis publiſhed an account of a very full and elaborate ſet of experiments on platina, in the Philoſophical Tranſactions. The properties of this new metal were ſtill farther inveſtigated by Margraaf in 1757, and by Macquer and Beaumè in 1758. It became afterwards the ſubject of reſearch with many other philoſophical chemiſts. Among theſe may be mentioned Buffon, Bergman, Sickingen, and more lately Guyton, Lavoiſier, and Pelletier. It was at laſt denominated *platina*, ſignifying *little ſilver*, from the Spaniſh word *plata*, *ſilver*.

2124 Where found. 2. Platina has only been found among the gold ores of South America, and eſpecially in the mine of Santa Fe near Carthagena, and in the diſtrict of Choco in Peru. It is found in the form of ſmall grains or ſcales, of a white or grayiſh colour, intermediate between that of ſilver and iron. Theſe grains are mixed with ſeveral other ſubſtances, as particles of gold, a black ferruginous ſand, and ſome particles of mercury. Some of theſe grains extend under the hammer, others, which ſeem to be hollow, containing particles of iron and a whitiſh powder, break to pieces. To theſe grains of iron is aſcribed the magnetic property which platina ſeems to poſſeſs (G).

2125 Purification. 3. To obtain platina in a ſtate of purity, it is firſt ſeparated from the ſubſtances with which it is contaminated. Mercury is driven off by expoſing it to a red heat, and the particles of iron are ſeparated by the magnet. The grains of platina are then heated with muriatic acid, which diſſolves the remaining part of the iron. By this proceſs, Bergman has obſerved, that the platina diminiſhes in weight about 0.05. The platina is now only alloyed with gold, which is to be ſeparated by diſſolving both in nitro-muriatic acid, and by precipitating the gold by means of the green ſulphate of iron. But even after theſe proceſſes, the platina is not in a ſtate of abſolute purity, as will appear afterwards (H).

2126 Properties. 4. This metal is of a white colour, but leſs bright than ſilver, and it poſſeſſes nothing of the brilliancy of either ſilver or gold. Platina is the denſeſt body, and therefore the heavieſt yet known. Its ſpecific gravity, when it is hammered, is 23; or, according to Chabaneau, 24. According to Guyton, it comes next to iron and manganeſe in hardneſs. It poſſeſſes very conſiderable malleability, for it may be hammered

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mical may be traced to a much earlier period. Some, who conſider them as remains of the Eygyptain hieroglyphics, pretend that they may be diſcovered on the table of Iſis, and employ them as a proof of the high antiquity, if not of the art of making gold, at leaſt of chemiſtry. We are told alſo that they correſpond with many other characters which the adepts have left us as emblems of their wiſdom.

"If we are deſirous of deciding without prejudice reſpecting both theſe explanations, it will be found neceſſary to make ourſelves acquainted with the oldeſt form of the characters, which, in all probability, like thoſe uſed in writing, were ſubjected to many changes before they acquired that form which they have at preſent. I can, however, mention only three learned men, Saumaiſe, Du Cange, and Huet, who took the trouble to collect theſe characters As I am afraid that my readers might be diſguſted were I here to inſert them, I ſhall give a ſhort abſtract of the concluſion which they form from them; but I muſt firſt obſerve that the oldeſt manuſcripts differ very much in their repreſentation of theſe characters, either becauſe they were not fully eſtabliſhed at the periods when they were written, or becauſe many ſuppoſed adepts endeavoured to render their information more enigmatical by wilfully confounding the characters; and it is probable alſo that many miſtakes may have been committed by tranſcribers.

"The character of Mars, according to the oldeſt mode of repreſenting it, is evidently an abbreviation of the word Θουρος, under which the Greek mathematicians underſtood that deity; or, in other words, the firſt letter Θ, with the laſt letter ς placed above it. The character of Jupiter was originally the intitial letter of Ζευς; and in the oldeſt manuſcripts of the mathematical and aſtrological works of Julius Firmicus the capital Z only is uſed, to which the laſt letter ς was afterwards added at the bottom, to render the abbreviation more diſtinct. The ſuppoſed looking-glaſs of Venus is nothing elſe than the initial letter, diſtorted a little, of the word Φωσφορος, which was the name of that goddeſs. The imaginary ſcythe of Saturn has been gradually formed from the two firſt letters of his name Κρονος, which tranſcribers, for the ſake of diſpatch, made always more convenient for uſe, but at the ſame time leſs perceptible. To diſcover in the pretended caduceus of Mercury the initial letter of his Greek name Στιλβων, one needs only look at the abbreviations in the oldeſt manuſcripts, where they will find that Σ was once written as C; they will remark alſo that tranſcribers, to diſtinguiſh this abbreviation from the reſt ſtill more, placed the C thus ∪, and added under it the next letter τ. If thoſe to whom this deduction appears improbable will only take the trouble to look at other Greek abbreviations, they will find many that differ ſtill farther from the original letters they expreſs than the preſent character ☿ from the C and τ united. It is poſſible alſo that later tranſcribers, to whom the origin of this abbreviation was not known, may have endeavoured to give it a greater reſemblance to the caduceus of Mercury. In ſhort, it cannot be denied that many other aſtronomical characters are real ſymbols, or a kind of proper hieroglyphyics, that repreſent certain attributes or circumſtances, like the characters of Aries, Leo, and others quoted by Saumaiſe. *Hiſt. of Invent.* iii. 53.

(G) Collet-Deſcoſtils obſerves, that among the metallic ſubſtances which are uſually found accompanying platina, there are two kinds of ferruginous ſand; of which one is attracted by the magnet, and ſoluble in acids. This contains titanium. The other has no magnetic property, and is only partially ſoluble in acids. This laſt contains a conſiderable proportion of chromic acid. *Ann. de Chim.* xlviii. 154.

(H) A new metal, or ſeveral new metals, have been diſcovered in platina, by ſome late experiments. Theſe will be mentioned in a future ſection.

mered out, although with difficulty, into very thin plates; and it is ſo ductile, that it may be drawn out into wire $\frac{1}{1940}$ of an inch in diameter. The tenacity of platina is very conſiderable. A wire of .078 of an inch in diameter will ſupport a weight without breaking, equal to more than 274 lbs. avoirdupois.

2127 Fuſing point unknown.

5. Platina is the moſt infuſible of all the metals. The temperature at which it enters into fuſion is unknown. But ſmall particles of platina have been fuſed by means of the blow-pipe, or by directing a ſtream of oxygen gas on red-hot charcoal. Guyton alſo ſucceeded in fuſing it by means of a flux, compoſed of eight parts of pounded glaſs, one of calcined borax, and one-half part of charcoal in powder. When platina has been expoſed to a white heat, it may be welded by hammering, like iron.

2128 Oxidation.

6. As platina is infuſible in the ſtrongeſt furnace heat, ſo it remains otherwiſe unchanged (1). It does not appear to undergo, like moſt other metals, any degree of oxidation; but if platina be diſſolved in 16 times its weight of nitro muriatic acid, by boiling the ſolution becomes at firſt of a yellow, and then changes to a brown colour. This ſolution is precipitated by means of lime, and the precipitate is in the form of a yellowiſh powder, which is the oxide of platina. The proportion of oxygen in this oxide is ſuppoſed not to exceed .07. But according to the experiments of Mr Chenevix, it is compoſed of

2129 Yellow oxide.

Platina,	87
Oxygen,	13
	100

2130 Green oxide.

The ſame chemiſt alſo found, that in the reduction of this oxid of platina, it became of a green colour, and remained for ſome time in that ſtate. Ammonia aſſumes a green colour when it holds oxide of platina in ſolution. This Mr Chenevix conſiders as a ſecond oxide of platina, and it contains

Platina,	93
Oxygen,	7
	100 *

Platina has alſo been oxidated by means of electricity. In Van Marum's experiments, a wire of this metal through which electric ſparks were ſent, burnt with a white flame, and was diſſipated in the form of fine powder or duſt.

7. Azote, hydrogen, and carbone, have no action whatever on platina.

2131 Phoſphuret.

8. Phoſphuret of platina was formed by Pelletier by mixing together equal parts of platina and phoſphoric glaſs, with one-eight of charcoal. This mixture being expoſed to the temperature of 32° of Wedgwood for an hour, yielded a ſmall button of phoſphuret of platina, of a ſilvery white colour, part of which had aſſumed the form of cubic cryſtals. It was ſo hard as to ſtrike fire with ſteel, and was not attracted by the magnet. It was covered with a dark coloured glaſs, which afterwards became green, bluiſh, and white. By expoſing this phoſphuret to a ſtrong heat, the phoſphorus is ſeparated, and burns on the ſurface, and the metal remains behind very pure and malleable. Pelletier has propoſed this proceſs for the purification of platina from other metals.

2132 Sulphuret.

9. Sulphur has been found in combination with native platina. When native platina is expoſed to the action of the blow-pipe on charcoal, it exhales the penetrating odour of ſulphur, accompanied with a vapour which does not render gold white, and which requires a higher temperature to ſublime it than mercury *.

I. Salts of Platina.

1. Sulphate of Platina.

By adding ſulphuric acid to a ſolution of platina in muriatic acid, Mr Chenevix obtained an inſoluble ſalt, which he found to be compoſed of

Oxide of platina,	54.5
Acid and water,	45.5
	100.0

2. Sulphate of Platina and Potaſh.

This triple ſalt is formed by adding a ſolution of potaſh to ſulphate of platina. The component parts of this ſalt are, ſulphuric acid, oxide of platina, and potaſh; but the proportions have not been aſcertained by Bergman, who examined it.

3. Sulphate of Platina and Ammonia.

This triple ſalt is formed in the ſame way as the former, by adding ammonia to the ſulphate of platina.

4. Nitrate of Platina.

Nitric acid has no action on platina, but it diſſolves the yellow oxide. Mr Chenevix precipitated the oxide of platina from its ſolution in nitro-muriatic acid by means of lime, and although it was added in exceſs, a great portion of platina remained in the liquor. The precipitate was rediſſolved in nitric acid, and evaporated to dryneſs. The reſult was, a ſubnitrate of platina, which conſiſted of

Yellow oxide	89
Nitric acid and water	11
	100

5. Nitrate of Platina and Potaſh.

When potaſh is added to a ſolution of nitrate of platina, cryſtals are depoſited forming a triple ſalt, and compoſed of nitric acid, oxid of platina and potaſh.

6. Nitrate of Platina and Ammonia.

This triple ſalt is formed by adding ammonia to a ſolution of nitrate of platina.

7. Muriate

* *Phil. Tranſ.* 1803. 314.

* *Ann. de Chim.* xxxviii. 149.

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(1) Guyton propoſes to conſtruct a pyrometer of platina. See *Ann. de Chim.* xlvi. 276.

7. Muriate of Platina.

2133 Preparation. Muriatic acid has no action on platina, but the muriate of platina may be obtained by diſſolving the metal in nitro-muriatic acid. Boiled in 16 parts of a mixture conſiſting of one part of nitric acid and three parts of muriatic acid, it is gradually diſſolved with effervescence. It may be alſo diſſolved in oxymuriatic acid. The ſolution of platina in muriatic acid is of a reddiſh or deep brown colour. It is extremely acrid and cauſtic, corrodes and burns animal matters, and leaves a dark brown ſpot on the ſkin. When the ſolution is concentrated, it depoſits on cooling, ſmall irregular cryſtals, nearly in the ſtate of powder, and of a browniſh-yellow colour. 2134 Properties. When theſe cryſtals are waſhed and dried, they are found to be leſs ſoluble by boiling in water, than even the ſulphate of lime. The ſolution is of a yellow colour. The muriate of platina has a harſh, aſtringent taſte; it is decompoſed by heat; the acid is driven off, and the oxide remains. It is alſo decompoſed by concentrated ſulphuric acid. Potaſh produces in this ſolution, ſmall reddiſh cryſtals, frequently in the form of octahedrons, conſtituting the triple ſalt already deſcribed. The ſame triple ſalt is formed by the ſulphate of potaſh. Ammonia, or the muriate of ammonia, alſo forms a triple ſalt, by being added to the ſolution of muriate of platina. Soda in ſufficient quantity occaſions a precipitate of the yellow oxide of platina, and a triple ſalt alſo is formed. Mr Chenevix found that the inſoluble muriate of platina is compoſed of

2135 Compoſition.

Oxide of platina	70
Acid and water	30
	100

8. Muriate of Platina and Soda.

Till the experiments of Collet-Deſcoſtils, little was known of this triple ſalt. It may be obtained by adding to a ſolution of platina a ſalt with baſe of ſoda. By concentration and cooling it cryſtallizes in the form of long priſms, and ſometimes in that of triangular tables, of a yellow or red colour. It is very ſoluble in water, and alſo in alcohol. It is decompoſed by muriate of ammonia, and by a ſolution of ſoda; but an exceſs of this ſalt re-diſſolves the precipitate. It may be reduced by the action of the blowpipe on charcoal. This cryſtallized triple ſalt, if it has no exceſs of acid, changes from a red colour to a green by expoſure to the air. If in this ſtate it be diſſolved in water, and oxymuriate of lime be added to it, a deep blue precipitate is formed, which being waſhed and collected, is ſoluble in muriatic acid, and communicates to it a beautiful blue colour. The addition of alcohol deprives the ſolution of its colour, but the oxymuriate of lime reſtores it *.

9. Muriate of Platina and Potaſh.

This ſalt is formed by adding potaſh to a ſolution of muriate of platina. Small cryſtals of a red colour, in the form of octahedrons, are precipitated, which are a triple ſalt conſiſting of muriatic acid, oxide of platina and potaſh.

10. Muriate of Platina and Ammonia.

1. A ſimilar triple ſalt is formed by adding ammonia to the ſolution of muriate of platina. The triple ſalt is precipitated in the form of cryſtalline grains, of a reddiſh yellow colour, which are ſoluble in water. By evaporating the ſolution of theſe triple ſalts to dryneſs, and by expoſing it to a ſtrong heat, the platina is reduced. This fact with regard to the fuſibility of platina by means of potaſh or ammonia, was obſerved by Bergman, and it is by this proceſs that platina is purified and wrought.

2. When this ſalt is precipitated by means of potaſh, a fulminating platina is obtained. This, according to Fourcroy and Vauquelin, by whom it was prepared, is a compound of oxide of platina and ammonia. When it is expoſed to ſudden heat, it decrepitates and is agitated with a rapid motion, but when the heat is gradually applied, it detonates violently *.

11. Oxalate of Platina.

Oxalic acid combines with the oxide of platina, and affords by evaporation cryſtals which are of a yellow colour.

12. Benzoate of Platina.

Benzoic acid, according to Trommſdorf, diſſolves a ſmall quantity of the oxide of platina. When this ſolution is evaporated, it cryſtallizes. This ſalt undergoes no change by expoſure to the air, and is not very ſoluble in water. The acid is driven off by heat, and the oxide of platina remains behind.

II. Alloys.

1. Platina combines with many of the metals, and forms with them alloys, ſome of which are of conſiderable importance in the working of this metal.

2136 Combines with arſenic. Platina forms an alloy with arſenic, which is brittle and very fuſible. It is in this ſtate of alloy that platina is ſuſceptible of being formed into different utenſils and inſtruments for which it is peculiarly fitted. It is firſt fuſed with this metal, and then caſt into moulds, at firſt in the form of ſquare plates. It is then expoſed to a red-heat, and hammered into bars. By the heating and hammering, the arſenic is driven off, and the metal is purified and becomes infuſible, but retains its ductility, ſo that it may be wrought like iron.

2. The alloys of tungſten, molybdena, chromium, columbium, titanium, uranium, and mangane∫e, are unknown; nor have the alloys of cobalt and nickel with this metal been examined.

2137 Biſmuth. 3. Platina combines with biſmuth by means of fuſion. This alloy is fuſible and hard in proportion to the quantity of biſmuth. It is altered by expoſure to the air; it becomes yellow, purple, and black.

2138 Antimony. 4. Platina readily combines with antimony, and forms a very brittle alloy. The antimony may be ſeparated by means of heat, but not completely. Some part remains, which diminiſhes the weight and ductility of the platina.

2139 Mercury. 5. It has been found extremely difficult to combine platina and mercury. Guyton had obſerved that the adheſive force of platina and mercury is greater than that

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* Ann. de Chim. xlviii. p. 165.

* Annal. de Chim. xlix. p. 179.

that of metals which do not combine with it, and that it is not inferior even to thoſe which readily form alloys; from which he conjectured that the alloy of platina and mercury might be effected by the following proceſs. He placed a very thin plate of pure platina at the bottom of a matraſs containing a quantity of mercury. The matraſs was put upon a ſand bath, and heat applied, till the mercury boiled and the matraſs became red-hot. When the platina was taken out, it was found to have acquired additional weight, and to have become very brittle. But this combination is different from the other combinations of mercury with the metals, for the platina did not loſe its ſolid form. Mr Chenevix, in the courſe of experiments and reſearches reſpecting a ſuppoſed new metal called palladium, ſucceeded in forming an amalgam with platina and mercury. He heated purified platina in the form of fine powder, with ten times its weight of mercury, and rubbed them together for a long time. The reſult was an amalgam of platina, which being expoſed to a violent heat, loſt all the mercury it contained, and the original weight of the platina remained.

2140 Zinc. 6. Platina readily combines with zinc, and forms with it a fuſible alloy, of a bluiſh colour, brittle, and hard. By heating, the zinc is ſublimed, and burns on the ſurface.

2141 Tin. 7. Platina alloys readily with tin. This alloy is one of the moſt fuſible. It is hard and brittle, when the two metals are in equal proportions; but tin in the proportion of 12 parts to one of platina, affords a very ductile alloy, which becomes yellow by expoſure to the air. From this it appears that platina diminiſhes the the ductility of tin.

2142 Lead. 8. Platina readily combines with lead, by means of fuſion. An alloy of equal parts of theſe metals is of a purpliſh colour, granulated in its fracture, brittle, and eaſily altered by expoſure to the air. The cupellation of platina by means of lead has been an object of conſiderable importance with chemiſts, in the view of being able to purify it in the ſame way as gold and ſilver; but on account of the infuſibility and refractory nature of platina, the attempts that have been made have rarely ſucceeded.

2143 Iron. 9. Dr Lewis failed in his attempt to combine platina with iron, but he obtained an alloy by fuſing together platina and caſt iron. This alloy was extremely hard, and poſſeſſed ſome degree of ductility. Platina, as it is found native, is frequently alloyed with iron.

2144 Copper. 10. Platina combines with copper by means of fuſion, and gives it hardneſs. When the proportion of copper is three or four times greater than that of platina, the alloy is ductile, ſuſceptible of a fine poliſh, and is not altered by expoſure to the air. This alloy has been employed in the fabrication of mirrors for teleſcopes.

2145 Silver. 11. Platina readily combines with ſilver by fuſion, although a very ſtrong heat is required. The platina greatly increaſes the hardneſs of ſilver, but diminiſhes its whiteneſs. When this alloy is kept in fuſion for ſome time, the two metals are ſeparated. During this fuſion, Dr Lewis obſerved the ſilver forced towards the ſides of the crucible with a kind of exploſion.

2146 Gold. 12. Gold combines readily with platina, but it requires a very powerful heat for the fuſion of theſe two metals. Platina diminiſhes the colour of gold, unleſs it be in very ſmall quantity. When the proportion of platina is above $\frac{1}{17}$, the colour of the gold begins to be altered. There is no perceptible change in the ſpecific gravity or the ductility of gold from this alloy.

Platina, on account of its peculiar properties, its infuſibility, denſity, and indeſtructibility, could it be obtained in ſufficient quantity, and at a moderate price, would undoubtedly prove one of the moſt uſeful and moſt important of the metals yet known. The importance and utility of platina, on account of its ſcarcity, have been hitherto limited to chemical purpoſes; and for different chemical inſtruments and utenſils, it has been found peculiarly appropriate, as there are few chemical agents whoſe effects it cannot reſiſt. There is indeed little doubt but it might be employed with equal advantage in the conſtruction of inſtruments and utenſils, in various arts and manufactures.

Sect. XXIII. *Of Palladium, a ſuppoſed new metal; and of Iridium and Osmium, two new Metals obtained from crude Platina.*

2147 Palladium announced. 1. In the month of April 1803, the diſcovery of a new metal, to which the name of *Palladium* was given, was announced in London. It was ſaid to poſſeſs the following properties: "1. It diſſolves in pure nitric acid, and makes a dark-red ſolution. 2. Green ſulphate of iron throws it down in the ſtate of a regulus from the ſolution. 3. If you evaporate the ſolution, you get a red calx, which diſſolves in muriatic or other acids. 4. It is thrown down by quickſilver, and by all the metals, but gold, platina, and ſilver. 2148 Properties. 5. Its ſpecific gravity, by hammering, is only 11.3; but by flatting as much as 11.8. 6. In a common fire the face of it tarniſhes a little, and turns blue; but becomes bright again, like other noble metals, on being ſtronger heated. 7. The greateſt heat of a blackſmith's fire would hardly melt it. 8. But if you touch it while hot, with a ſmall bit of ſulphur, it runs as eaſily as zinc." Nothing was ſaid of the hiſtory of the diſcovery; but from the unuſual manner in which it was announced, 2149 Mr Chenevix's ſuſpicions and experiments. Mr Chenevix conceiving it to be an impoſition, procured a ſpecimen, which being ſubjected to various teſts, he found could not be referred to any of the known metals. He afterwards purchaſed the whole quantity which was offered to ſale. The ſubſtance had been wrought by art, had been rolled out in flatting mills, and was offered for ſale in thin laminæ. The largeſt, about three inches in length, and half an inch in breadth, weighing about 25 grains, were ſold at a guinea. When this ſubſtance was poliſhed, it could ſcarcely be diſtinguiſhed from platina. It was flexible, but not very elaſtic. The ſpecific gravity of ſome pieces was 10.972, while others were only 11.482.

The effects of galvanic electricity upon palladium were the ſame as upon gold and ſilver. Expoſed to the blow-pipe, the ſide removed from the immediate action of the flame became blue. Expoſed in an open veſſel to a greater degree of heat than the fuſing temperature of gold, no appearance of fuſion or oxidation was obſerved. When the heat was increaſed, a melted button was obtained, which had loſt a little of its weight, but was increaſed in ſpecific gravity. The addition of ſulphur renders it more fuſible, and extremely brittle. There ſeems to be no action between charcoal and palladium. Mr Chenevix found that this ſubſtance formed alloys with gold, platina, ſilver, copper, lead, and ſome other metals. The alloy with lead was the hardeſt of all, but extremely brittle, and its ſpecific gravity was 12. He alſo ſubjected this ſubſtance to other experiments, with alkalies, ſome of the earths, ſeveral of the acids, and ſome of the ſalts; and from the whole he concludes that it would be difficult to ſay of what metal, or of what combination of metals, palladium conſiſts.

2150 Is an alloy.

2. Mr Chenevix ſtill proſecuted his experiments, and he concluded at laſt, that this ſuppoſed new metal is an alloy of platina and mercury. It muſt however, be obſerved, that he did not arrive at this diſcovery by analyzing palladium, for he failed in every attempt with that view. It was by combining platina and mercury in certain proportions, that he compoſed a ſubſtance which he conſidered as exactly ſimilar in all its properties to palladium. The proceſs by which he ſucceeded in forming palladium, or a ſubſtance exactly ſimilar, was by diſſolving 100 grains of platina in nitro-muriatic acid, and then adding 200 grains of red oxide of mercury. This being inſufficient to ſaturate the exceſs of acid, more was added till it ceaſed to be diſſolved. A quantity of green ſulphate of iron was then poured into a long-necked matraſs, to which the mixed ſolution of platina and mercury was added, and the whole placed upon a ſand bath. In leſs than half an hour, a precipitate formed, and the inſide of the matraſs was lined with a thin metallic coat. The liquor was paſſed through a filter, and the precipitate, after being digeſted with muriatic acid, was well waſhed and dried. The whole quantity collected amounted to 276 grains, which were compoſed of 92 of platina, and 184 of mercury. It was in the form of a fine powder, with a metallic luſtre. It was put into a charcoal crucible, and fuſed into a button. The ſpecific gravity was 11.2. It was entirely ſoluble in nitric acid, eaſily fuſed by ſulphur, and precipitated by green ſulphate of iron; thus exhibiting all the properties of palladium, which Mr Chenevix concludes, is compoſed of two parts of mercury, and one of platina.

2151 Specific gravity remarkable.

3. One of the moſt ſingular circumſtances with regard to this alloy, if ſuch it can be called, is its ſpecific gravity, which is not only far below the mean of the ſpecific gravity of the two metals, but conſiderably inferior to either of its elements. The ſpecific gravity of platina is 22, according to ſome greater, and that of mercury is nearly 14, and yet the ſpecific gravity of the compound is only 10.972, little more than the half by calculation. But although we have no reaſon to doubt the accuracy and preciſion of Mr Chenevix's experiments, and although we are little diſpoſed to place any confidence in the aſſertion of the unknown diſcoverer of this ſubſtance, from the extraordinary circumſtances under which it has been announced, yet we do not conſider the reſult of theſe experiments fully ſatiſfactory, in proving palladium to be an alloy of platina and mercury (K). Every attempt which Mr Chenevix made to analyze this ſuppoſed new metal, failed. It is true, he was equally unſucceſsful in decompoſing the alloy of platina and mercury which he had formed, and which reſembled palladium in moſt of its properties which were compared. The attempts which have been made to repeat the experiments of Mr Chenevix, have not ſucceeded. No other chemiſt has yet been able to form the compound of platina and mercury, which poſſeſſes the properties of palladium *. Till, therefore, Mr Chenevix ſhall have extended his reſearches concerning this alloy, or till it ſhall have been examined by ſome other chemiſt, we muſt remain in ſuſpenſe with regard to its nature.

2152 His experiments not fully ſatiſfactory.

2153 Iridium.

4. Two other metals have been juſt announced. They were diſcovered in crude platina by Mr Tennant, in analyzing the black powder which remains after diſſolving platina. To the firſt of theſe metals Mr Tennant has given the name of *iridium*, from the various colours it aſſumes in ſolution. It poſſeſſes the following properties. It is ſoluble in all the acids, but leſs ſoluble in muriatic acid, with which it forms octahedral cryſtals. The ſolution with much oxygen is deep red; with a ſmaller proportion, green or deep blue. It is partially precipitated by the alkalies, and by all the metals except gold and platina. Infuſion of galls and pruſſiate of potaſh deprive this ſolution of its colour, but without any precipitate; thus affording an eaſy teſt of its preſence. The oxide, therefore, loſes its oxygen by water alone. When combined with gold or ſilver, it cannot be ſeparated by the uſual proceſs of refining theſe metals. The ſame ſubſtance was examined by Deſcoſtils and Vauquelin, and the properties which they aſcribe to this metal are the following. 1. It reddens the precipitates of platina made by muriate of ammonia. 2. It is ſoluble in muriatic acid. 3. It is precipitated by the infuſion of galls and pruſſiate of potaſh.

2154 Oſmium.

5. The other new metal is obtained by heating the black powder with pure alkali in a ſilver crucible. The oxide of this metal combines with the alkali, and may be expelled by an acid, and obtained by diſtillation, being very volatile. It does not redden vegetable blues, but ſtains the ſkin of a deep red or black. The oxide in ſolution with water has no colour; but by combining with alkali or lime, becomes yellow. With the infuſion of nut-galls it gives a very vivid blue colour. It is precipitated by all the metals excepting gold and platina. An amalgam may be formed with mercury, by agitating it with the aqueous ſolution of this oxide. When this amalgam is heated, the mercury is driven off, and the pure metal remains behind in the ſtate of black powder. To this metal Mr Tennant has given the name of *oſmium*, on account of the ſtrong ſmell of the oxide †.

Such is the account of theſe metals which we have received. Should a fuller detail reach us in time, we ſhall

* *Phil. Trans.* 1803, p. 290.

† *Nichol. Jour.* viii. p. 118, & 220.

(K) Fourcroy and Vauquelin have thrown out a conjecture that palladium is probably an alloy of platina and a new metal diſcovered in crude platina by Collet-Deſcoſtils and Mr Tennant. *Ann. de Chim.* xlviii. 185.

ſhall not fail to lay it before our readers, either in an appendix to this treatiſe, or under the names of the metals themſelves, in the order of the alphabet, in the courſe of the work.

Chap. XV. Of the ATMOSPHERE.

The atmoſphere is that inviſible elaſtic fluid which ſurrounds the earth. Its phyſical properties, ſuch as denſity, elaſticity, and preſſure, have been long known; but its compoſition and conſtituent parts muſt be ranked among the diſcoveries of modern chemiſtry. In the preſent chapter, we propoſe only to take a ſhort view of the nature, conſtitution, and changes of the atmoſphere, reſerving the full diſcuſſion of the latter to meteorology, to which it properly belongs.

Sect. I. *Of the Component Parts of the Atmoſphere.*

2155 Is a compound

2156 of oxygen and azotic gaſes.

1. The air of the atmoſphere was conſidered by the ancients as one of the four elements of which all bodies are compoſed. The ſame opinion was held by all philoſophers, previous to the diſcoveries of modern chemiſtry. It was univerſally admitted to be a ſimple homogeneous ſubſtance, till by the diſcovery of oxygen gas by Dr Prieſtley, and that of azotic gas by Scheele, it was fully demonſtrated that theſe two ſubſtances are the chief ingredients in atmoſpheric air.

2157 Phyſical properties.

2. This compound poſſeſſes all the phyſical properties of the different kinds of air which we have hitherto examined. It is inviſible, elaſtic, and may be indefinitely expanded and compreſſed. The ſpecific gravity of atmoſpheric air is 0.0012, or it is 816 times lighter than water. A hundred cubic inches weigh 31 grains troy; but in conſequence of the elaſticity of the air, the abſolute weight and the denſity muſt vary with the temperature and preſſure. The eſtimation which we have here given, is taken at the ordinary temperature of the atmoſphere, between 50° and 60°, and when the barometer, which indicates the preſſure, ſtands at 30 inches. The denſity muſt vary by diminiſhing, according to the height above the ſurface of the earth. The experiments of naturaliſts, whoſe attention has been particularly directed to this ſubject, have ſhewn that the diminution of denſity is in the ratio of the compreſſion, and therefore, that the increaſe of denſity is in geometrical progreſſion, while the heights increaſe in arithmetical progreſſion.

2158 Method of eſtimating the proportions.

3. After the diſcovery of the compoſition of atmoſpheric air, it became an object with philoſophers to determine the proportions of its component parts. It was obſerved by Prieſtley and Scheele, and other philoſophers who were occupied in the proſecution of their diſcoveries, that a certain portion of a given quantity of atmoſpheric air only was abſorbed during the proceſſes of combuſtion and reſpiration. It was obſerved too, that certain ſubſtances combined with the portion of atmoſpheric air which diſappeared during theſe proceſſes, and that the ſame quantity of atmoſpheric air ſuffered no farther diminution, whatever length of time it was expoſed to the action of theſe ſubſtances. The portion of the air abſorbed is the oxygen gas, and on this principle is founded the conſtruction of thoſe inſtruments which have been denominated *eudiometers*, becauſe they are employed to meaſure the purity of a given portion of air, by aſcertaining the quantity of oxygen gas which it contains. Different eudiometers have been propoſed for this purpoſe, but all depending on the ſame principle, namely, the abſtraction of oxygen gas from a given quantity of air. The reader will probably recollect the effects which take place by mixing together nitrous gas and the air of the atmoſphere, or oxygen gas. When theſe gaſes come into contact, red fumes are produced; the atmoſpheric air is partially diminiſhed; but the oxygen gas entirely diſappears. This is owing to the combination of the nitrous gas with the oxygen gas, forming nitric acid, which, if the experiment be made over water, is abſorbed; thus diminiſhing the bulk of the air by the quantity of oxygen gas abſtracted. This is the principle of the firſt eudiometer, which was propoſed by Dr Prieſtley; but it has been found that the reſults and experiments with this kind of eudiometer are far from being uniform and conſtant. It is ſubject to variation from the difference of purity of the nitrous gas employed, the water over which the experiment is made, and even the form and conſtruction of the apparatus. The variations in the reſults of different experiments by different philoſophers, are from 22. to 30. of oxygen gas in 100 parts of atmoſpheric air.

Scheele propoſed a different eudiometer. A mixture of iron filings and ſulphur formed into a paſte with water, abſorbs the whole of the oxygen gas of any given portion of atmoſpheric air. The diminution of bulk of a portion of air, expoſed to the action of this ſubſtance, therefore, indicates the proportion of oxygen gas which it contains; but this abſorption goes on ſlowly, and is therefore an objection to this mode of aſcertaining the proportions of atmoſpheric air. This objection has been removed by an improvement of this eudiometer, in which hydrogenated ſulphuret of potaſh or lime is ſubſtituted for the iron filings and ſulphur. This is prepared by boiling together ſulphur and lime water, or a ſolution of potaſh in water. By the uſe of this ſulphuret, the abſorption takes place in a few minutes. A given portion of air is agitated in a bottle with this ſulphuret, taking care to exclude the external air with a ground ſtopper. The diminution of the bulk of this quantity of atmoſpheric air ſhews the proportion of oxygen gas which it contained.

Volta propoſed to explode a given portion of atmoſpheric air with hydrogen gas, by means of the electric ſpark. The hydrogen and oxygen combine together and form water; and the diminution of the bulk of the airs employed is in proportion to the quantity of water formed. But to this method of aſcertaining the quantity of oxygen gas in a given portion of atmoſpheric air, it has been objected, that the proportion of hydrogen gas requires to be accurately adjuſted; for if it exceed, the ſuperabundant quantity increaſes the bulk of the remaining air; and, if the proportion be too ſmall, the oxygen and azote will form nitric acid by the action of electricity, and thus the reſiduary quantity of air will be too much diminiſhed.

When phoſphorus is expoſed to the air, it abſorbs the oxygen readily, and is converted into phoſphorous acid. This, which was firſt propoſed by Achard, has been improved by Berthollet, for the purpoſes of a eudiometer.

Component Parts of the Atmoſphere.

diometer. A given portion of air is expoſed to the action of phoſphorus, in a veſſel over water; when the abſorption has ceaſed, the remaining air is meaſured, the diminution of which indicates the quantity of oxygen gas which it contained.

Mr Davy has propoſed the green ſulphate or muriate of iron diſſolved in water, impregnated with nitrous gas. This ſolution is prepared by tranſmitting nitrous gas through green muriate or ſulphate of iron diſſolved to ſaturation in water. All the apparatus neceſſary is a ſmall graduated tube, having its capacity divided into 100 parts, and greateſt at the open end, and a veſſel for containing the fluid. The tube is filled with the air to be examined, and then introduced into the the ſolution. To promote the abſorption, it is gently moved from a perpendicular to a horizontal poſition. In a few minutes the experiment is completed, and the whole of the oxygen condenſed by the nitrous gas in the ſolution, in the form of nitric acid. But in this proceſs it is neceſſary to obſerve the period at which the diminution ſtops, for after this the volume of reſidual gas is increaſed by the decompoſition of the nitric acid, by means of the green oxide of iron *.

From a number of comparative experiments made by Mr Davy, with different endiometers, and from other experiments on air in different places, and collected under different circumſtances, it appears, that the component parts of atmoſpheric air are always nearly the ſame. Theſe proportions are from .21 to .22 of oxygen gas, and from .78 to .79 of azotic gas. The conſtituent parts, therefore, of atmoſpheric air by bulk may be taken at

2159 Compoſition.

Oxygen gas	22
Azotic	78
	100

But in eſtimating the proportions of given bulks of atmoſpheric air, it is neceſſary, as we have already hinted, to take into account the denſity and temperature, otherwiſe very great anomalies muſt happen.

2160 Water.

4. It is univerſally admitted, that water exiſts in the atmoſphere; but philoſophers are greatly divided with regard to the quantity of water, and the ſtate in which it exiſts in the air. To aſcertain the quantity of water, inſtruments called *hygrometers*, or *meaſurers of moiſture*, have been contrived; the quantity of which is indicated by certain changes which take place by its abſorption; but none of theſe inſtruments that have yet been invented are ſuſceptible of great accuracy, and perhaps to this is owing the very different reſults in eſtimating the quantity of water in the atmoſphere. There is alſo a very great difference of opinion whether this water exiſts in the atmoſphere in the ſtate of water, or whether it has been converted into vapour. According to the firſt opinion, the water is held in ſolution by the air, and the quantity increaſes

2161 In the ſtate of vapour.

as the temperature of the air is increaſed. But according to others, the water of the atmoſphere is in the ſtate of vapour. According to the experiments of naturaliſts, the quantity of water in the atmoſphere varies in different climates, and at different ſeaſons of the year, from $\frac{1}{60}$ to $\frac{1}{300}$ part of the weight of the atmoſphere.

Conſtitution of the Atmoſphere.

5. When lime-water, or an alkaline ſolution, is expoſed to the air, it is ſoon covered with a cruſt or pellicle. This is owing to the abſorption of carbonic acid, and the converſion of the alkali or lime to the ſtate of carbonate. This ſhews that carbonic acid gas exiſts in the atmoſphere. This gas has been found not only on the ſurface of the earth, where the denſity of the atmoſphere is greateſt, but alſo on the tops of ſome of the higheſt mountains. The quantity of carbonic acid gas in the atmoſphere is ſuppoſed to vary from .01 to .005 part.

2162 Carbonic acid gas.

SECT. II. *Of the Constitution of the Atmosphere.*

2163 Different opinions.

1. The component parts of the atmoſphere are, azotic gas, oxygen gas, water, and carbonic acid gas. Here a queſtion has ariſen among philoſophers, whether theſe parts are chemically combined, or merely form a mechanical mixture. According to one ſet of philoſophers, the oxygen and azotic gaſes of the atmoſphere are in chemical union, becauſe their proportions are always found to be uniform and conſtant, which it is ſuppoſed could not be the caſe from the inequality of the cauſes acting in diminiſhing the quantity of oxygen gas, by the different proceſſes of combuſtion and reſpiration, which are going on in the ſurface of the earth, if the component parts of the air were not in chemical combination. The air of the atmoſphere too, it is ſaid, poſſeſſes properties very different from the artificial mixture of its component parts. The proceſſes of combuſtion and reſpiration continue for a greater length of time in the latter, becauſe it parts with a greater proportion of its oxygen, and for the ſame reaſon it is more diminiſhed by nitrous gas. According to others, the air of the atmoſphere is merely a mechanical mixture. This opinion is ſupported by Mr Dalton, in ſome ingenious ſpeculations on the conſtitution of mixed gas, and particularly of the atmoſphere. The principle on which Mr Dalton's hypotheſis is founded is, that the particles of homogeneous elaſtic fluids only mutually act upon each other, and that the particles of an elaſtic fluid of one kind are neither attracted nor repelled by the particles of an elaſtic fluid of a different kind, when they are mixed together. According to this hypotheſis, therefore, the particles of the oxygen gas of the atmoſphere mutually act on each other, or are only attracted and repelled by thoſe of their own kind *.

2164 In chemical union.

2165 Mechanical mixture.

2. A difference of opinion alſo prevails, whether the vapour of water, as it exiſts in the atmoſphere, be merely a mechanical mixture, or chemically combined. The former opinion is alſo ſupported by Mr Dalton, upon the principle that all gaſes mixed with vapour, expand in a proportional degree to the elaſticity of the vapour in that temperature.

SECT. III. *Of the Changes of the Atmosphere.*

2166 Temperature.

1. The changes which are produced in the atmoſphere by heat and cold, are too obvious to eſcape obſervation; but it was not till the invention of the thermometer that theſe changes could be obſerved and marked with any degree of accuracy; and even after the invention and improvement of this inſtrument, it was long before any ſcientific application was made of

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* *Jour. Roy. Inſt.* i. p. 45.

* See *Manch. Mem.* vol. v.

the changes of the temperature which it indicated. The variable temperature of the ſame day, the great difference between midnight and midday, and the ſtill greater difference between the heat of ſummer and the cold of winter, ſeem to hold out a number of inſulated facts, without reſemblance or connexion, and incapable of being arranged under any general law. But more comprehenſive views, and more extended obſervations, have not only ſhewn the poſſibility of eſtabliſhing a general principle, but have enabled philoſophers to arrange and claſſify phenomena which were otherwiſe ſeemingly unconnected.

2167 The ſun the ſource of heat.

2. The great ſource of heat is the ſun. This is fully demonſtrated by the increaſe of temperature being in proportion to the duration and greater or leſs obliquity of the ſun's rays. It has been imagined that the earth is heated by central fires: but this opinion ſeems to be fully diſproved, by obſerving that the temperature depends invariably on the abſence or preſence of the ſun; that this temperature is diminiſhed, at leaſt to a certain extent, by going deeper into the earth; and that the cold is greateſt in places moſt diſtant from the ſun's rays; ſo that the temperature which is moſt uniform within the tropics, diminiſhes, other things being equal, in proportion to the diſtance from the equator towards the poles.

2168 Fixed points of temperature important.

3. In conſidering the difference of temperature which is obſerved in different places, it became an object with philoſophers to diſcover ſome fixed points from which the whole amount of the changes for any given period could be aſcertained. This was firſt thought of by Mayer, who propoſed the method uſed by aſtronomers, of finding the mean of certain large periods, as for years and months; and he made the diſcovery by which the mean annual temperature of two latitudes being known, the mean annual temperature for every other degree of latitude may be alſo found. The application of this rule has been greatly improved and extended by Mr Kirwan, and upon this principle he conſtructed tables which exhibit the mean annual temperature for all degrees of latitude from the equator to the poles. Theſe tables were conſtructed by finding from obſervation the temperature of what he calls a ſtandard ſituation, that is, a place leſs liable to be affected by adventitious cauſes, but where the cauſe of temperature, or the communication of heat from the ſource, was moſt uniform and conſtant; and having diſcovered this ſtandard ſituation, to compare the temperature of every other ſituation with it. The land, Mr Kirwan thought, owing to the operation of cauſes which occaſion variations leſs eaſily appreciable, would not afford reſults ſufficiently uniform. This ſituation, he then concluded, was to be ſought for on the water; and that part of the ocean which he choſe, was the immenſe tract of water which includes that part of the Atlantic lying between the 80° of north latitude, and the 45° of ſouth latitude, extended weſtward as far as the gulf ſtream, and to within a few leagues of the coaſt of America; and all that part of the Pacific ocean reaching from the 45° north latitude to the 40° ſouth latitude, and from the 20° to the 275° of longitude eaſt from London. This includes the greater part of the ſurface of the globe. But for the method of conſtructing theſe tables, and for the tables themſelves, we refer our readers to the article METEOROLOGY, where they will be inſerted.

2169 Annual temperature.

The difference of temperature, it may be obſerved, within 10° of the equator and within the ſame diſtance from the poles, is very ſmall; and the variation of temrature for different years within the ſame ſpace, is alſo found to be very little: but as the diſtance increaſes from the equator towards the poles, the difference of temperature is greater. In latitudes under 35°, it ſcarcely ever freezes, excepting in very elevated ſituations, and it ſcarcely ever hails in latitudes higher than 60°. In places near the ſea, between the latitudes of 35° and 60°, it generally thaws when the ſun's altitude is 40°, and ſeldom begins to freeze till the meridian altitude be below 40°.

2170 Monthly.

4. Mr Kirwan has alſo conſtructed tables to mark the mean monthly temperature. In every latitude the mean temperature of the month of April approaches nearly to the mean annual heat of that latitude. And from this analogy he proceeded, ſuppoſing that the temperature is always regulated by the direct action of the ſolar rays, unconnected with the other circumſtances which occaſion conſiderable variations. Taking all theſe into the account, and endeavouring to reduce them to ſtrict calculation, he found it impracticable; and therefore he conſtructed his tables, partly from principle, and partly from the beſt obſervations he could procure from ſea journals, and ſimilar ſources of information. The mean monthly temperature in theſe tables alſo refers to the ſtandard ocean.

2171 Coldeſt ſeaſon.

2172 Warmeſt.

The coldeſt weather alſo prevails about the middle of January in all climates, and the warmeſt in July; but if it depended immediately on the ſun's heat, the greateſt heat ſhould prevail in the latter end of June, and the greateſt cold in the latter end of December. But as the earth requires a conſiderable time to abſorb heat, ſo alſo it is ſome time before what has been abſorbed is given out. All theſe obſervations and calculations refer to the ſurface of the ocean, which is leſs ſubject to variation from cauſes, the influence of which could not be aſcertained with preciſion.

2173 The earth heats the atmoſphere.

6. But as the earth is the chief ſource of heat in the atmoſphere that ſurrounds it, the temperature muſt decreaſe with the elevation above the earth, and in the higheſt regions of the atmoſphere, where the air is perfectly free from clouds, the greateſt cold muſt prevail. Hence, in conſequence of this elevation above the level of the ocean, the higheſt mountains, even under the equator, are covered with perpetual ſnow. Mr Bouguer found the cold on the top of Pinchinca in South America, immediately under the line, to vary from 7° to 9° below the freezing point every morning before ſunriſe, and hence at a certain height, which varies in almoſt every latitude, it conſtantly freezes at night in every ſeaſon; although in ſome latitudes, in the warmer climates, it thaws next day. This height he calls the lower term of congelation, and he places it at the height of 15,577 feet between the tropics. In latitude 28° he thinks it ſhould commence in ſummer at the height of 13,440 feet above the level of the ſea. But at ſtill greater heights it never freezes at all, becauſe the vapours do not aſcend ſo high. This height M. Bouguer denominates the *upper term of congelation*; and immediately under

the equator he fixes it at 28000 feet. As the weather is not ſubject to great variations under the equator, the height of both theſe terms is nearly conſtant: but in other latitudes this height is variable, both in ſummer and winter, in proportion to the degree of heat which prevails; and as there is a mean annual temperature peculiar to each latitude, ſo is there a mean height for each of theſe terms peculiar to each latitude. By taking the differences between the mean temperatures of every latitude, and the point of congelation, it will appear that whatever proportion the difference under the equator bears to the height of either of theſe terms, the ſame proportion will the difference peculiar to every other latitude bear to their height.

2174
Land and water different in temperature.

7. But there is not the ſame uniformity or capacity in air, land, and water, for receiving and returning heat. Hence ariſe very conſiderable deviations in the temperature of places, as they are more or leſs connected with theſe bodies. Air, when it is perfectly tranſparent, receives very little heat from the rays of the ſun as they paſs through it. Air which is over ſeas or large tracts of water, is generally many degrees warmer in winter, and colder in ſummer, than air which is incumbent on land, becauſe the land receives the heat much more readily than the water; in general the air participates of the temperature of thoſe ſubſtances with which it is in contact. Land, if dry, receives heat rapidly, but tranſmits or conducts it to great depths very ſlowly; but water receives it more ſlowly, and diffuſes it more rapidly. From experiments made by Dr Hales, it appears that the earth is much heated during the ſummer, but that this heat deſcends very ſlowly, great part of it being communicated to the air; that during winter, the earth gives out to the air the heat it had received during the ſummer, and that wet ſummers muſt be ſucceeded by cold winters, becauſe the heat is carried off by the greater proportion of evaporation during the wet ſeaſon. At the depth of 80 or 90 feet below the ſurface of the earth, the temperature is found to vary very little, and it generally approaches to the mean annual heat. The temperature of the cave at the obſervatory of Paris, which is 90 feet below the pavement, is about 53.5°. The greateſt variation which has been obſerved, does not exceed half a degree, and this only happens in very cold years. Hence, too, the temperature of ſprings is almoſt uniformly the ſame throughout the year, and correſponds with the mean annual temperature of the climate.

2175
Temperature varies according to the height of places.

8. There is not only a conſiderable difference in the temperature of land and water; but this variation alſo holds with regard to the land itſelf, according as it is elevated above the ſurface, and according to the nature of the ſurface, whether it is covered with vegetables, or only exhibits bare rocks, or ſterile ſand. A conſiderable deviation alſo is obſerved to take place, in proportion to the diſtance from the ocean. All theſe cauſes, however, are greatly modified by the relative ſituation of places with regard to ſeas and oceans, mountainous regions, and extenſive tracts of level country covered with thick foreſts, or improved by cultivation. Theſe cauſes too are modified by particular winds, which produce conſiderable deviations, as they proceed from the ocean, from low, flat countries, or elevated regions.

2176
Preſſure.

9. Another remarkable change to which the atmoſphere is ſubject, is the difference of its weight or preſſure. The air, like all other matter, is influenced by the law of gravitation, by which it preſſes with a certain force on the ſurface of the earth. It has been found that the meaſure of this force is nearly equal to 15lb. on every ſquare inch. The variations which take place in the atmoſphere are meaſured by the barometer. The mercury in the barometrical tube is ſupported by a column of air of an equal baſe, and ſince this column of air and the mercury in the tube mutually balance each other, it follows that they are of the ſame weight, and therefore the barometer may be employed as a meaſurer of the weight or preſſure of the air.

2177
The ſame at the level of the ſea

10. The firſt general fact with regard to the weight of the atmoſphere is, that in all places at the level of the ſea, the barometer ſtands nearly at the ſame point, and the mean height is about 30 inches. But as the elevation is increaſed, the barometer ſinks, becauſe then there is a ſhorter column of air to ſupport it, which is therefore lighter. In no place does the weight of the air continue always the ſame. It is ſubject to daily variations, which are greater or ſmaller according to the latitude of the place, or the influence of particular cauſes. In all places within the tropics, the variations of the barometer have been obſerved to be ſmalleſt, and in elevated ſituations the variations are conſiderably ſmaller than on the level of the ſea. The deviations of the mercury from its mean annual altitude are more frequent and extenſive in the neighbourhood of the poles than in that of the equator, and they are greater and more frequent without the tropics in winter than in ſummer.

2178
Cauſes.

11. The cauſes which have been propoſed to account for theſe variations, are changes of temperature, velocity of winds, and the agency of vapours. The air is ſubject to the action of heat, by which it is rarefied or condenſed, according to the increaſe or diminutions of temperature. Denſe air is heavier than that which is rarer; but if the maſſes of air remain the ſame, the weights muſt be the ſame, and conſequently the heights to which they elevate the mercury will be alſo equal. If, therefore, a change of temperature occaſion a variation of the barometer, it muſt be by increaſing or diminiſhing the maſs of the atmoſphere. But it appears from obſervation, that a variation of the maſs of the atmoſphere is not a neceſſary conſequence of a change of temperature, for the mercury is often at the ſame height at different ſeaſons, and at different places at the ſame time, when the difference of temperature is very great. But even when the mercury changes with the temperature, this variation is often directly contrary to what it ought to be. The barometer has ſometimes riſen with an increaſe of temperature, inſtead of falling by the rarefaction of the air. The changes of temperature are very inconſiderable in the higher regions of the atmoſphere, ſo that it would appear that the barometer can be little affected by changes of temperature. Mr Kirwan has endeavoured to ſhow, that the influence of winds, or a greater or ſmaller quantity of vapours exiſting in the atmoſphere,

Changes of the Atmoſphere.

can have little effect in elevating or depreſſing the barometer. According to Mr Kirwan, the variations of the barometer, or the difference of preſſure of the air of the atmoſphere, can only be accounted for from an accumulation of air over thoſe places in which the mercury exceeds its mean height, and from the diminution or ſubtraction of the natural quantity of air, over thoſe regions in which the mercury falls below its mean height.

2179 Winds.

12. The winds conſtitute another remarkable change in the atmoſphere. The winds in general are ſubject to great irregularity; but in ſome parts of the world they are pretty regular and uniform. Between the 30° of N. Lat. and the 30° S. Lat. the wind, when it is not counteracted by local cauſes, continues to blow conſtantly from the ſame points. On the north ſide of the equator, that is, from the equator to the 30° of N. Lat. it blows from the north-eaſt, and from the equator to the 30° S. Lat. it blows from the ſouth-eaſt. This is called the *trade-wind*. Immediately under the equator the wind is obſerved to be pretty nearly from the eaſt; that is, about the place where the two currents meet, the one from the north-eaſt, and the other from the ſouth-eaſt; but receding from the equator, the direction of it deviates more and more from the eaſterly point, till it reaches the intermediate point between north and ſouth, and then conſtitutes the north-eaſt trade-wind on the north ſide, and the ſouth-eaſt trade-wind on the ſouth ſide of the equator. Were the cauſes which produce the conſtancy and uniformity of the trade-winds uninfluenced by others, theſe winds would prevail without variation within the limits or near the boundaries of the torrid zone: but they are greatly counteracted, and ſubject to great variations, from the unequal influence of land and water, in rarefying or condenſing the air.

2180 Trade-winds.

13. As the air of the atmoſphere is a fluid body, and therefore ſubject to all the laws of fluids, if any part be removed, the remainder ruſhes in to reſtore the equilibrium, and hence an agitation or wind is produced, as air is capable of indefinite dilatation and compreſſion. The denſer air being heavier, muſt ſink, and the rarefied air aſcends, when air of unequal denſities is mixed together. The greateſt degree of mean temperature is within the torrid zone, in conſequence of the ſun's rays being more perpendicular, and acting with greater force on the earth's ſurface. The air therefore round the equator undergoes the greateſt degree of rarefaction, and this extends to the north and ſouth, in proportion to its diſtance from the equator, or rather its diſtance from the ſun's place. Thus, when the ſun is perpendicular to the equator, or middle part of the torrid zone, the air in that place being moſt rarefied, becomes lighter, aſcends, and its place is filled with the colder air from the north and ſouth. And thus, as long as the ſun's influence continues to rarefy the air, would a north and ſouth wind blow to that quarter where the rarefied air, being rendered lighter, had aſcended. But as the earth has a diurnal motion on its axis from weſt to eaſt; thoſe parts of the earth's ſurface to the weſtward are firſt heated, and conſequently the incumbent air is firſt rarefied. The denſer air from the eaſt muſt therefore ruſh in to reſtore the equilibrium. Thus, there is produced an eaſterly wind. But there is another current of air from the north and ſouth: the two currents coming from the north-eaſt trade-wind on the north ſide of the equator, and the ſouth-eaſt trade-wind on the ſouth ſide. Such are the cauſes which are generally ſuppoſed to produce the regular trade-winds.

Waters.

2181 Deviations.

14. Theſe winds are regular and uniform in open oceans, ſuch as the Pacific or Atlantic, but they are ſubject to conſiderable variation from the unequal rarefaction of the air over land and water. Thus, iſlands ſituated within the very courſe of the trade-winds have regular land and ſea breezes, which are often directly contrary to the trade-wind. In conſequence of the air incumbent on the land being more rarefied during the day, the wind blows from the ſea conſtituting the ſea breeze; but the air over the ſea being warmer during the night, the winds blows from the land, from which it is called the *land wind*. To a ſimilar cauſe is owing another remarkable deviation from the uniformity of the trade winds, which is obſerved in the great Indian ocean. Here the winds called *monſoons* blow from one quarter during ſix months of the year, and from an oppoſite direction during the remaining ſix months. While the ſun is in the northern tropic, the air over the extenſive Indian continent is greatly rarefied; and, in conſequence of this rarefaction, the denſer air from the ocean ruſhes in to reſtore the equilibrium, and hence the current of the air or wind continues during this period of the year, conſtituting the ſouth-eaſt monſoon. But when the ſun paſſes the equator to the ſouthward, the air over the ſouthern hemiſphere is more influenced by his rays, and therefore more rarefied. The denſer air then ruſhes in from the north, and thus produces the north-weſt monſoon, which blows during our winter, when the ſun is in the ſouthern tropic.

2182 Monſoons.

2183 Part of the air ſuppoſed to be abſtracted.

15. But even a ſuperficial obſervation will ſhew, that the phenomena of the winds cannot be ſatisfactorily accounted for, merely upon the general principle of the unequal rarefaction of the air over land and water. Thus ſudden changes of wind often happen in particular places, which are extremely limited, and altogether unconnected with the difference of denſity of the air over land and water. The hurricane has ſwept the land, whoſe effects have not been felt on the neighbouring ocean, and the ſtorm frequently agitates the ocean without reaching the land. Theſe and other phenomena of the winds, equally inexplicable, have been aſcribed by naturaliſts to the abſtraction or ſudden deſtruction of a certain quantity of the air of the atmoſphere in particular places. But for the full diſcuſſion of this ſubject and the other phenomena of the atmoſphere, we muſt refer our readers to METEOROLOGY.

CHAP. XVI. OF WATERS.

1. We have already treated of the component parts of water, of the diſcovery of its compoſition, and of its moſt remarkable properties, and eſpecially thoſe which it exhibits by a change of conſtitution, as in the ſolid ſtate or that of ice, in the liquid ſtate, and in the ſtate of vapour. In theſe views water was conſidered as perfectly pure; but this is rarely or never the caſe, as it is found in nature. Rain water, which is the pureſt, is not entirely free from impregnation, even when collected

2184 Water not found pure.

lected before it falls to the earth. It is ſlightly contaminated with certain ſubſtances, which it held in ſolution, as it exiſted in the clouds, or with which it combined in its paſſage through the atmoſphere. But waters as they flow on the ſurface of the earth, or are carried through the ſtrata under the ſurface, muſt diſſolve thoſe ſoluble ſubſtances with which they come in contact. It is the object of our preſent inveſtigation to examine the waters as they are found in nature, and the ſubſtances with which they are impregnated.

2. The properties of pure water are almoſt obvious to the ſenſes, ſo that few ſubſtances, at leaſt in any quantity, can be diſſolved in water, without being eaſily recognized. Thus, the ſaline, nauſeous taſte of ſea-water, the fetid odour, or the aſtringent taſte of mineral ſprings, muſt readily be diſtinguiſhed by theſe ſtriking qualities. But although it is probable that the remarkable diverſity of waters, from their obvious properties, could not fail to be early obſerved by mankind, it is only by chemical inveſtigation that the nature of the ſubſtances to which they owe theſe properties, can be aſcertained; and indeed we are indebted to the diſcoveries and improvements of modern chemiſtry for the knowledge which we poſſeſs of the nature and proportion of the ingredients which enter into the compoſition, either of ſea water or mineral ſprings.

2185 Can only be examined by chemical agents.

This ſubject has been particularly inveſtigated by Bergman, Weſtrumb, Black, Fourcroy, Klaproth, and Kirwan. In the three following ſections we propoſe to treat, 1. Of ſea-water; 2. Of mineral waters; 3. Of the method of analyzing them.

Sect. I. *Of Sea-water.*

2186 Properties.

1. The ſaline taſte of ſea-water, we have already obſerved, could not fail to make it be diſtinguiſhed from pure water; and this taſte, it is well known, is chiefly derived from common ſalt which it holds in ſolution. Sea-water is alſo diſtinguiſhed by a nauſeous bitter taſte, which is aſcribed to the animal and vegetable matters which are floating in it. This taſte has been conſidered as in ſome meaſure foreign to it; for it is only found in the water on the ſurface of the ocean or near the ſhores. Sea-water taken up at conſiderable depths, contains only ſaline matters. The ſpecific gravity of ſea-water varies from 1.0269 to 1.0285. Its greater denſity is owing to the ſalts which are diſſolved in it; and to this impregnation alſo it is owing, that it is not frozen till the temperature is reduced nearly to 28°.

2187 Salts.

2. The ſalts which are chiefly found in ſea-water, are muriate of ſoda, or common ſalt, muriate of magneſia, ſulphate of magneſia, ſulphate of lime and ſoda. The quantity of ſaline ingredients in the waters of the ocean varies from $\frac{1}{24}$ to $\frac{1}{35}$ part. Mr Kirwan makes the average quantity about $\frac{1}{28}$ of its whole weight. The quantity of ſaline contents of water, taken up by Lord Mulgrave at the back of Yarmouth ſands, in latitude 53°, amounted nearly to $\frac{1}{32}$; while Bergman found the water taken up in the latitude of the Canaries to contain about $\frac{1}{24}$ of its weight of ſaline matter. Theſe quantities, however, vary, even in the ſame latitude, during rainy and dry ſeaſons, near the land, or the mouths of great rivers. The difference of latitude does not ſeem to make any conſiderable difference in the proportion of ſaline matter. In latitude 80° north, 60 fathoms under ice, ſea water taken up by Lord Mulgrave, yielded about $\frac{1}{28}$; in latitude 74° nearly the ſame; and in latitude 60°, $\frac{1}{29}$. Pages obtained four per cent. from water taken up in latitude 81°, and the ſame quantity of ſaline matter from water taken up in latitudes 45° and 39° north. In ſouthern latitudes, the proportion was ſtill greater; he found it to contain the following proportions:

2188 Proportion varies.

2189 In ſouthern latitudes.

Lat.		
49°	50′ S.	4.1666 per cent. of ſaline matter.
46°	00′	4.5
40°	30′	4
28°	54′	4
20°	00′	3.9
1°	16′	3.5

In the Mediterranean the proportion is ſaid to be ſtill greater; but the Euxine and Caſpian ſeas are found to be leſs ſalt than the ocean. This alſo is the caſe with the Baltic. If the ſaline matters of the waters of the ocean did not conſiſt of different kinds, the proportion of ſalts which it contains might be aſcertained by the ſpecific gravity. In the following table the ſpecific gravity of ſea water taken up in different latitudes has been determined by Mr Bladh. The temperatures are reduced by Mr Kirwan to 62° of Fahrenheit; and the longitude is reckoned by Bladh from Teneriffe.

2190 Specific gravity in different latitudes.

Lat.	Long.	Sp. Gr. at 62°
N.	E.	
59° 39′	8° 48′	1,0272
57° 18′	18° 48′	1,0269
	W.	
57° 1′	1° 22′	1,0272
54° 00′	4° 45′	1,0271
44° 32′	2° 04′	1,0276
	E.	
44° 07′	1° 00′	1,0276
40° 41′	0° 30′	1,0276
34° 40′	1° 18′	1,0280
29° 50′	0° 00′	1,0281
	W.	
24° 00′	2° 32′	1,0284
18° 28′	3° 24′	1,0281
16° 36′	3° 37′	1,0277
14° 56′	3° 46′	1,0275
10° 30′	3° 49′	1,0272
5° 50′	3° 28′	1,0274
2° 20′	3° 26′	1,0271
1° 25′	3° 30′	1,0273
S.		
0° 16′	3° 40′	1,0277
5° 10′	6° 00′	1,0277
10° 00′	6° 05′	1,0285
14° 40′	7° 00′	1,0284
20° 06′	5° 30′	1,0285
25° 45′	2° 22′	1,0281
	E.	
30° 25′	7° 12′	1,0279
37° 37′	68° 13′	1,0276

From this table it appears that the proportion of ſaline matter is greateſt near the tropics; and the ſmaller quantity near the equator is aſcribed to the great quantity of rain that uſually falls on that part of the globe.

2191 In the Baltic. 3. The experiments of Mr Wilcke ſhow that the proportion of ſaline matter in the Baltic is leſs than that of the ocean, and that it is ſalter during the prevalence of a weſterly wind, by which the water is driven from the ocean, than during an eaſterly wind. The following is the ſpecific gravity of the waters of the Baltic, taken during the prevalence of different winds, and reduced by Mr Kirwan to the temperature of 62°.

Wind.	Specific gravity.
Eaſt,	1.0039
Weſt,	1.0067
Weſt, a ſtorm,	1.0118
North-weſt,	1.0098

From this it appears, that the proportion of ſaline matters in the Baltic is increaſed by the influx of water from the ocean, and is conſiderably influenced during a ſtorm, when the wind blows from that quarter.

4. Dr Watſon has eſtimated the quantity of ſalt in water of different ſpecific gravities. It is alſo reduced to the temperature of 62° by Mr Kirwan, as in the following table.

Salt.	Specific gravity.
$\frac{1}{24}$	1.0283
$\frac{1}{25}$	1.0275
$\frac{1}{26}$	1.0270
$\frac{1}{27}$	1.0267
$\frac{1}{28}$	1.0250
$\frac{1}{30}$	1.0233
$\frac{1}{39}$	1.018;
$\frac{1}{44}$	1.0033
$\frac{1}{56}$	1.0105
$\frac{1}{108}$	1.0040
$\frac{1}{162}$	1.0023

Theſe experiments were made with ſolutions of common ſalt, which was not perfectly pure, and therefore it is allowed that they may correſpond pretty nearly with the proportions of ſaline matter in ſea-water of the ſame ſpecific gravities.

2192 Proportions. 5. The proportions of the different ſalts in an analyſis by Bergman, are the following.

Muriate of ſoda,	30.911
Muriate of magneſia,	6.222
Sulphate of lime,	1.000
	38.133

In 1000 parts of water taken up near Dieppe, Lavoiſier found the following ſalts.

Muriate of ſoda,	1375
——— of lime and magneſia,	256
——— of magneſia,	156
Lime, - -	87
Sulphate of ſoda and magneſia,	84
	1958

SECT. II. *Of Mineral Waters.*

2193 Characters. 1. The name of *mineral waters* has been given to thoſe waters which are diſtinguiſhed by the ſmell, taſte, or colour, from pure water, the obvious properties of which are, tranſparency and inſipidity. Theſe peculiarities of taſte, ſmell, and other properties, are owing to the impregnation of certain mineral ſubſtances which they have acquired in their paſſage through the ſoil or ſtrata of the earth. The effects which ſuch waters produce on the animal economy, early attracted the attention of mankind, and led to their application as remedies in the cure of diſeaſes. It was long indeed before any other diſtinction of mineral waters was made, except what was indicated by their ſenſible qualities, and their effects on the human conſtitution. From theſe properties mineral waters have been divided into four claſſes: 1. Acidulous or gaſeous waters; 2. Saline waters; 3. Sulphureous or hepatic waters; and 4. Chalybeate waters. 2194 Claſſes.

2195 Acidulous. 1. Acidulous waters are diſtinguiſhed by their penetrating acid taſte, the facility with which they boil; by ſparkling when they are poured into a glaſs; and by the emiſſion of bubbles of air, by agitation. The acid with which they are impregnated is generally the carbonic. Theſe waters redden the tincture of turnſole, and precipitate lime-water.

2196 Saline. 2. The ſecond claſs, or the ſaline waters, are ſufficiently characterized by their taſte, which varies according to the nature of the ſalt with which they are impregnated.

2197 Sulphureous. 3. The ſulphureous or hepatic waters are at once recognized by their fetid odour, and by blackening ſome metallic ſubſtances, as lead and ſilver. Some of theſe waters are impregnated with ſulphurated hydrogen gas, while in others it is combined with lime, or with an alkali.

2198 Chalybeate. 4. The fourth claſs, or the chalybeate waters, are diſtinguiſhed by an aſtringent taſte. With the pruſſiate of lime they give a blue colour, or a black with the infuſion of nut galls. This property is owing to a portion of iron which is held in ſolution, either by carbonic or ſulphuric acid. Sometimes carbonic acid is in exceſs, and then the water has a penetrating ſlightly acid taſte.

2199 Subſtances found in mineral waters. 2. The ſubſtances which have been found in mineral waters, as they have been enumerated by Mr Kirwan, belong either to the claſs of gaſeous bodies, acids, alkalies, earths, or ſalts.

2200 Gaſes. 3. Oxygen gas was firſt diſcovered in waters by Scheele. It is generally in ſmall proportion, and does not exiſt in waters with ſulphurated hydrogen gas, or iron, becauſe it is incompatible with theſe ſubſtances. Azotic gas has been found in the waters of Buxton, Harrowgate, and Lemington Priors. Common air was firſt diſcovered in mineral waters by Mr Boyle; the quantity ſcarcely exceeds $\frac{1}{28}$ of the bulk of the water. Fixed air or carbonic acid was firſt diſcovered in Pyrmont waters by Dr Brownrig. The proportions are very variable; but there are few mineral waters which are entirely free from it. A hundred cubic inches of moſt waters, contain from 6 to 40 of carbonic acid gas. A hundred cubic inches of Pyrmont waters contain, according to Bergman, 95 of fixed air; according

ing to Dr Higgins, 160, and according to Weſtrumb, 187 cubic inches. Sulphurated hydrogen gas is the principal ingredient in ſulphureous or hepatic water. Carbonated hydrogen gas is ſaid to have been detected in ſome mineral waters in Italy.

2201 Acids. 4. The next claſs of ſubſtances found in mineral waters, are the acids. Sulphuric acid has never been found, except in combination with other ſubſtances, forming ſalts in mineral waters. With ſome of theſe ſalts it exiſts in exceſs. Sulphurous acid has been detected in many of the hot mineral ſprings in Italy, in the vicinity of volcanoes. Muriatic acid has only been found in mineral waters, in combination with other ſubſtances. Nitric acid is ſaid alſo to exiſt in mineral waters in Hungary, in a combined ſtate. Boracic acid has been found in a ſeparate ſtate, in ſome lakes in Italy.

2202 Alkalies. 5. The alkalies are rarely found combined in mineral waters. In the ſtate of carbonate they are frequent. Soda only was detected in the hot mineral ſprings of Iceland, by Dr Black.

2203 Earths. 6. Few of the earths, except in combination, have been found in mineral waters. Lime, it is ſaid, exiſts uncombined in ſome waters; but Bergman obſerves that it muſt be in hot, and not in cold mineral waters. Dr Black detected ſilica in the waters of Geyſer and Rykum in Iceland. It has been found in thoſe of Carlſbad by Klaproth, and it has not unfrequently been obſerved by others in different mineral waters.

2204 Salts. 7. The ſalts which have been found in mineral waters, are ſulphates, nitrates, muriates, and carbonates.

Sulphates.—Sulphate of ſoda is frequently found in the waters of ſprings and lakes. Sulphate of ammonia has been found in mineral waters, in the neighbourhood of volcanoes. Sulphate of lime is one of the moſt common ſubſtances in moſt ſprings. Sulphate of magneſia or Epſom ſalt, is not unuſual in many mineral ſprings. Sulphate of alumina is rarely found in mineral waters; it is more commonly found in the ſtate of triple ſalt or alum. Sulphate of iron is frequent in the ſprings and lakes of volcanic countries. It has alſo been found in other places. Sulphate of copper has only been detected in the waters which iſſue from copper mines.

Nitrates.—Nitrate of potaſh or nitre is rarely found in mineral waters. It has, however, been detected in ſeveral ſprings in Hungary; ſome traces of it have been obſerved in wells in Berlin, and in ſome ſalt ſprings in Germany. Nitrate of lime has been detected in ſprings in the ſandy deſerts of Arabia. Nitrate of magneſia is ſaid alſo to have been found in mineral waters.

Muriates.—Muriate of potaſh is but rarely found in mineral waters. It has been detected in the ſprings of Uleaburg in Sweden. Muriate of ſoda or common ſalt exiſts in almoſt all waters, as well as in the ocean. Muriate of ammonia is not very frequent in waters; it has been detected, however, in ſome mineral lakes in Italy, and alſo in Siberia. Muriate of barytes is very rare, but according to Bergman, it has been found in ſome mineral waters. Muriate of lime is very generally found in mineral ſprings. Muriate of magneſia is very common in mineral waters. Muriate of alumina has been detected in ſome mineral waters by Dr Withering. Muriate of manganeſe was found by Bergman in ſome mineral waters in Sweden, and it has lately been diſcovered, in ſmall proportion, in the waters of Lemington Priors, by Mr Lambe.

Carbonates.—Carbonate of potaſh, it is ſaid, has been found in ſome mineral waters. Carbonate of ſoda exiſts very frequently in the waters of many ſprings and lakes. Carbonate of ammonia has been found in the waters of Rathbone place in London, by Mr Cavendiſh, and in ſome waters in France. Carbonate of lime is commonly found in almoſt all waters, and it is held in ſolution by an exceſs of carbonic acid. Carbonate of magneſia very frequently exiſts in mineral waters. When it is fully ſaturated with carbonic acid, it is ſoluble in water, without any exceſs of acid. Carbonate of alumina is ſaid to have been found in the waters of Avor in Anjou, in France. Carbonate of iron is frequently found in mineral waters. It is to this that chalybeate waters owe their diſtinguiſhing properties.

8. *Borax*, or the ſubborate of ſoda, is found in ſome lakes in Thibet and Perſia.

2205 Hydroſulphurets. 9. *Sulphurated alkali* and *ſulphurated lime*, or the hydro-ſulphurets of ſoda and of lime, have been found in mineral waters. It is to theſe ſubſtances that hepatic or ſulphureous waters owe their diſtinctive properties.

2206 Bitumen. 10. Bituminous ſubſtances have alſo been diſcovered in ſome mineral waters. Sometimes they have been found combined with an alkali. Waters alſo ſometimes contain vegetable and animal matters, but theſe are not, properly ſpeaking, to be conſidered as ingredients in theſe waters.

SECT. III. *Of the* ANALYSIS *of* MINERAL WATERS.

2207 Phyſical properties. In the analyſis of mineral waters, the firſt thing to be attended to is to aſcertain the temperature and ſituation of the ſprings from which they are obtained. The ſenſible properties are then to be examined, ſuch as colour, tranſparency, ſmell and taſte. Of the phyſical properties of mineral waters, one of the moſt important and the firſt to be aſcertained, is the ſpecific gravity. By this means, although not with perfect accuracy, the quantity of ſaline ingredients may be known. But it is only by means of chemical operations that the nature of the ſubſtances with which mineral waters are impregnated, can be determined; and by obtaining theſe ſubſtances in a ſeparate ſtate, or forming new combinations, that their quantity or proportions can be accurately aſcertained. In the analyſis of mineral waters, therefore, after diſcovering their phyſical properties, the object of the chemiſt is firſt to detect the nature of the ſubſtances, and then the quantity or proportion of theſe ſubſtances which they contain. In both theſe we ſhall follow the method pointed out by Mr Kirwan, in his Eſſay on the analyſis of mineral waters.

I. Of the Method of Diſcovering the Subſtances in Mineral Waters.

1. The nature of the component parts of mineral waters is diſcovered by the addition of certain ſubſtances which produce changes of different kinds. The ſub-

ſtances employed for this purpoſe are known in chemiſtry by the name of *teſts* or re-agents, becauſe they act upon the ſubſtances with which the waters are impregnated, by decompoſing them, and forming new combinations.

2208 Teſts.

2209 Gaſeous bodies.

2. Gaſeous ſubſtances are eaſily detected, either by their eſcaping in the form of bubbles when the water is expoſed to the air, or, if they are more permanently held in ſolution, by boiling a quantity of the water in a retort, and receiving the gas over water or mercury. The nature of the gas, thus collected, may then be examined by the uſual teſts for gaſes.

2210 Carbonic acid.

3. Carbonic acid is detected by the infuſion of litmus, not, however, when the acid is ſaturated with any baſe, unleſs the acid be in exceſs. Saturated lime water may alſo be employed as a teſt for carbonic acid. One cubic inch of carbonic acid gas in 7000 grains of water, may be diſcovered by this teſt. Theſe effects are not produced by carbonic acid, after the water has been boiled.

2211 Mineral acids.

4. The infuſion of litmus, or paper tinged with it, is alſo employed as a teſt for mineral acids exiſting in waters. A red colour is produced, either when the acid is combined, or united with a baſe in exceſs. In this caſe the redneſs is permanent, and is not deſtroyed by boiling.

2212 Sulphurated

5. Sulphurated hydrogen gas reddens the infuſion of litmus, and blackens ſilver or lead, or the ſolutions of theſe ſalts. It is alſo eaſily recognized by its peculiar odour.

2213 And carbonated hydrogen gas.

6. Carbonated hydrogen gas burns with common air without exploſion; is not abſorbed by lime-water, and has no peculiar ſmell.

2214 Fixed alkalies.

7. The fixed alkalies produce a reddiſh brown colour with the infuſion of turmeric. The ſame change takes place with the alkaline and earthy carbonates. The infuſion of Brazil wood aſſumes a blue colour. Paper tinged blue with litmus, and reddened with vinegar, may be alſo employed as a teſt for alkalies; and by all the alkaline and earthy carbonates, the original blue colour is reſtored. The muriate of magneſia is precipitated only by the fixed alkalies. Potaſh forms with nitric acid a priſmatic ſalt; with acetic acid a ſalt which does not deliqueſce, and with ſulphuric acid, a ſalt which effloreſces. Ammonia, when in conſiderable quantity, is detected by the ſmell. If the proportion be ſmall, it may be diſcovered by diſtilling part of the water with a gentle heat.

2215 Carbonates.

8. The carbonates of the earths and the metals are precipitated by expoſure to the air, or by boiling and evaporation. Carbonates of lime, of alumina, and of iron, are precipitated by boiling for a quarter of an hour. Carbonate of magneſia is only partially precipitated by the ſame proceſs.

2216 Iron.

9. Iron either in the ſtate of carbonate, or combined with ſome other acid, is detected by tincture of galls, which produces a black or purple colour. A very minute portion of iron is detected by this teſt. Three grains of cryſtallized ſulphate of iron diſſolved in five pints of water, ſtrike a purple colour in five minutes, with a ſingle drop of this tincture. With this teſt the colour aſſumes different ſhades, according to the nature of the other ſubſtances which are in combination. If the water contains a carbonate of an alkali or an earthy ſalt, the colour is violet; it is dark purple with other alkaline ſalts; with ſulphate of lime it is firſt whitiſh, and afterwards black; and with ſulphurated hydrogen gas, the colour is purpliſh red. The latter, Mr Kirwan ſuſpects, is occaſioned by manganeſe. Iron diſſolved by carbonate of ammonia, is at firſt whitened, and afterwards blackened by tincture of galls. In the cauſtic fixed alkalies the precipitate is at firſt crimſon red, but afterwards becomes black. Pruſſian alkali is a ſenſible teſt of iron; the precipitate is blue: but if an alkali exiſts in the water, it prevents a ſmall portion of iron from ſtriking a blue colour with this teſt, until it be ſaturated with an acid.

2217 Sulphuric acid.

10. Sulphuric acid is detected by muriate, nitrate, or acetate of barytes, nitrate or acetate of lead, nitrate of mercury, nitrate, muriate, or acetate of ſtrontites, and nitrate, muriate, or acetate of lime.

2218 Muriatic.

11. Muriatic acid is readily detected by nitrate of ſilver. It forms a white precipitate, or a cloud in the water. If there are any carbonates of alkalies or earths in the water, they muſt be previouſly ſaturated with nitric acid. Sulphuric acid, or the ſulphates, muſt be precipitated by nitrate or acetate of barytes. Acetate and ſulphate of ſilver may be alſo employed for the ſame purpoſe.

2219 Boracic.

12. Boracic acid, when it is uncombined, is detected by acetate of lead; but the alkaline and earthy carbonates muſt be previouſly ſaturated with acetic acid. The ſulphates muſt be decompoſed by means of acetate of ſtrontites, and the muriates by acetate of ſilver.

2220 Lime.

13. Lime is readily detected with oxalic acid; but if the water contains any mineral acid, it muſt be previouſly ſaturated with an alkali. Barytes, if any exiſts in the water, muſt be precipitated by ſulphuric acid. Magneſia is precipitated very ſlowly with oxalic acid, by which it is readily diſtinguiſhed from lime.

2221 Barytes.

14. Barytes is detected by diluted ſulphuric acid, with which it inſtantly forms an inſoluble white precipitate.

2222 Magneſia and alumina.

15. Magneſia and alumina are both precipitated by means of pure ammonia and lime water; but it is neceſſary that carbonic acid, if any exiſts in the water, be previouſly ſeparated by means of a fixed alkali, and by boiling. If lime-water is employed, the ſulphuric acid muſt be firſt precipitated with nitrate of barytes. If the two earths are precipitated together, the alumina may be ſeparated from the magneſia, by boiling them with pure potaſh, which combines with the alumina.

2223 Silica.

16. Siliceous earth may be diſcovered by evaporating a large quantity of water nearly to dryneſs, and then by rediſſolving the precipitate in nitric or ſulphuric acid, and afterwards evaporating to dryneſs. The dry maſs, rediſſolved in water and filtered, leaves the ſilica on the filter.

2224 Sulphates.

17. Mr Kirwan gives the following directions for diſcovering the ſulphates.

Sulphate of ſoda is detected by ſeparating ammonia by gentle diſtillation, and then by evaporating to one-half, and afterwards by adding lime-water, while any precipitate is formed. By this means all the other ſulphates are precipitated. By farther evaporation, and the addition of a few drops of alcohol and oxalic acid, the whole of the lime is ſeparated. To the filtered reſiduum add a ſtrong ſolution of nitrate of lime; and if the alkaline ſulphates exiſt in the quantity of eight grains in 1000 of the liquid, a precipitate will appear. To aſcertain whether the baſe of this alkaline ſalt be potaſh or ſoda, add to an equal quantity of the water acetate of barytes; filter the ſolution, and evaporate to dryneſs. Add alcohol to ſeparate the other ſalts. This ſolution filtered and evaporated to dryneſs gives an acetate of potaſh or ſoda; if the former, it deliqueſces, but if it be the latter, it effloreſces by expoſure to the air.

2225 Sulphate of lime. 18. Sulphate of lime is depoſited by evaporation to a few ounces, if it be contained in the proportion of four grains to 1000. It affords a precipitate with muriate of barytes, oxalic acid, or alcohol; the latter of the ſpecific gravity of 0.848 produces a cloud inſtantaneouſly, in a ſolution of one grain of the ſalt in 1000 of water.

2226 Alum. 19. The teſt for alum is carbonate of lime. With this, alum forms a precipitate. If the water contain muriate of barytes, it muſt be precipitated with diluted ſulphuric acid. A ſulphate of any of the metals may be precipitated by means of an alkaline pruſſiate.

2227 Sulphate of magneſia. 20. The hydroſulphuret of ſtrontites affords a good teſt for ſulphate of magneſia, and it does not give an immediate precipitate with any other ſalt; but the water ſhould be free from any exceſs of acid.

2228 Of iron. 21. Sulphate of iron is detected by expoſing it in an open veſſel to the air for a few days; or it may be precipitated from the water by means of alcohol.

2229 Muriate of potaſh and ſoda. 22. To detect the muriate of potaſh and of ſoda, it is neceſſary, firſt, to ſeparate the ſulphates, if any exiſt in the mineral water, which is done by means of alcohol and nitrate of barytes. The earthy nitrates and muriates are decompoſed by diluted ſulphuric acid, and the nitric and muriatic acids are expelled by heat. The ſalts formed with ſulphuric acid may be ſeparated by alcohol and barytic water, ſo that nothing can now remain but alkaline nitrates and muriates. The laſt is decompoſed by acetate of ſilver, and if a precipitate is thus formed, the water contains muriate of ſoda or of potaſh. To ſeparate theſe from potaſh or ſoda, evaporate to dryneſs, and treat the dry maſs with ſtrong alcohol for 24 hours in a temperature of 60°. The acetates are thus diſſolved and depoſited by evaporation. The acetate of potaſh is known by its deliqueſcence, and the acetate of ſoda effloreſces.

2230 Of ammonia. 23. Muriate of ammonia is to be detected by firſt ſeparating the ſulphates by the acetate of barytes, and then evaporating the ſolution to dryneſs. The maſs can only conſiſt of acetates and alkaline muriates. Diſſolve the dry maſs in alcohol, and let it remain for 24 hours in the temperature of 60. All the ſalts are diſſolved, except the alkaline muriates. The reſiduum diſtilled with quicklime will give out ammonia, which will precipitate the ſolutions of iron, alum or lead, previouſly introduced into the receiver.

2231 Of barytes. 24. Muriate of barytes is diſcovered by ſulphuric acid. This is the only barytic ſalt yet found in mineral waters.

2232 Of lime. 23. To detect muriate of lime, firſt ſeparate the ſulphate of lime by evaporation, to a few ounces; add alcohol, and afterwards nitrate of barytes. Evaporate the filtered ſolution to dryneſs, treat the maſs with alcohol; evaporate the ſolution to dryneſs, and re-diſſolve the reſiduum in water. If a precipitate be formed, by adding nitrate of ſilver, oxalic or ſulphuric acid, the ſolution then may contain muriate of lime; if to a portion of the ſolution, carbonate of lime be added, alumina is precipitated, if the muriate of alumina exiſt in the water, but not muriate or nitrate of magneſia. Pure ammonia will precipitate magneſia from its combination with the nitric or muriatic acid. And if none of theſe earths appear, the muriatic acid detected in the water muſt be united to lime.

2233 Of magneſia. 26. Muriate of magneſia is diſcovered by decompoſing the ſulphates by means of nitrate of barytes. Filter the ſolution, evaporate to dryneſs, and diſſolve the reſiduum in alcohol. Evaporate this ſolution to dryneſs, and diſſolve the reſiduum in water. The nitrates of lime and magneſia, and the muriates of lime, magneſia and alumina, can only exiſt in the ſolution. Carbonate of lime precipitates alumina; pure ammonia precipitates magneſia. Muriatic acid is detected by nitrate of ſilver. To aſcertain whether the muriatic acid be united to magneſia, treat another portion of the ſolution with ſulphuric acid and alcohol. If no alumina has been found, and no precipitate now appears, magneſia is the only earth retained in the ſolution.

2234 Of alumina and iron. 27. To detect the muriates of alumina and iron, the alkaline carbonates, if they exiſt in the water, ſhould be ſaturated with nitric acid, and the ſulphates decompoſed with nitrate of barytes. By adding carbonate of lime to a portion of the water filtered and purified, the muriates of alumina and iron will be precipitated. Muriate of manganeſe is alſo ſeparated by carbonate of lime.

2235 Nitrate of potaſh and ſoda. 28. To diſcover the nitrates of potaſh and of ſoda, precipitate the ſulphates with acetate of barytes, and the muriates with acetate of ſilver. Evaporate to dryneſs, and diſſolve the reſiduum in alcohol. The alkaline nitrates, and a portion of acetate of lime remain undiſſolved. Filter off the undiſſolved nitrates, waſh them with alcohol, and rediſſolve them in water. Carbonate of magneſia decompoſes nitrate of lime. To ſeparate the nitrate of magneſia thus formed, evaporate to dryneſs, add alcohol to the dried maſs; the nitrate of magneſia is diſſolved, but the alkaline nitrates remain untouched.

2236 Of lime. 29. To detect nitrate of lime, evaporate the water conſiderably to ſeparate the ſulphate of lime which it may contain, and add alcohol to ſeparate the other ſulphates. The ſulphates being filtered off, and the alcohol expelled by heat, oxalic acid added to the ſolution, will produce a precipitate, if there be any lime in it. Decompoſe the muriates with acetate of ſilver; filter the ſolution, and evaporate it to dryneſs; diſſolve the dry maſs in alcohol; evaporate this to dryneſs, and rediſſolve it in water. If nitrate of lime exiſt in the ſolution, ſulphuric acid will diſcover it.

2237 Of magneſia. 30. To diſcover nitrate of magneſia, the ſulphates and muriates are firſt to be ſeparated; the ſolution being filtered, and evaporated to dryneſs, the reſiduum is to be diſſolved in alcohol. Evaporate this ſolution to dryneſs, and diſſolve the reſiduum in water. Add to the ſolution pure potaſh, which precipitates the earthy acetates and the nitrate of magneſia. Filter the ſolution, evaporate to dryneſs, and treat the reſiduum with alcohol, which diſſolves the alkaline acetates,

tates, and leaves the nitrate of potaſh untouched; by which proceſs it muſt appear, that nitrate of magneſia previouſly exiſted in the water.

2238 Bitumen. 31. Alkalies combined with bitumen are ſometimes found in mineral waters. Theſe mineral ſoaps, or bituminated alkalies, as they are called by Mr Kirwan, form a coagulum with the acids. This coagulum is ſoluble in the alkalies.

2239 Extractive matter. 32. Extractive matter, which is ſometimes found in mineral waters, is diſcovered by means of nitrate of ſilver, with which it forms a brown precipitate, but the water containing it muſt be freed from ſulphuric and muriatic acids with nitrate of lead. Three grains of the precipitate, according to Weſtrumb, indicate one grain of extractive matter.

2240 Animal. 33. Animal extractive matter gives a very diſagreeable taſte and ſmell to water. It is ſoluble in alcohol.

2241 Incompatible ſalts. 34. The following is a liſt of ſalts which are incompatible with each other, or which cannot exiſt together in the ſame water.

1. Alkaline carbonates; and earthy or metallic ſulphates, muriates, or nitrates.
2. Sulphuric acid; and earthy nitrates, muriates, or carbonates.
3. Alkaline ſulphates; and earthy nitrates, or muriates.
4. Sulphate of ſoda; and muriate of potaſh.
5. Sulphate of potaſh; and nitrate of ſoda.
6. Sulphate of ammonia; and nitrate of potaſh, and muriate of potaſh.
7. Sulphate of magneſia; and nitrate or muriate of lime.
8. Alum; and nitrate of lime and of magneſia, or muriate of magneſia.
9. Nitrate of lime; and muriate of potaſh, muriate of ammonia, of barytes, or magneſia.
10. Nitrate of magneſia; and muriate of barytes, and of potaſh.
11. Muriate of magneſia; and nitrate of ſoda or lime *.

II. Of the Method of aſcertaining the Proportions of Subſtances in Mineral Waters.

2242 Phyſical properties firſt aſcertained. 1. In examining any mineral water, it has been already mentioned, that it is neceſſary, firſt to aſcertain the phyſical properties, and eſpecially the ſpecific gravity, from which the quantity of ſaline matter, as Mr Kirwan obſerves, may be eſtimated. The method he propoſes is the following. He ſubtracts 1000, the ſpecific gravity of pure water, from the ſpecific gravity of the mineral water to be examined, expreſſed in whole numbers, and multiplying the product by 1.4, which gives the weight of the ſalts freed from their water of cryſtallization. Thus, a ſolution of common ſalt, whoſe ſpecific gravity is 1.079. A thouſand ſubtracted from this leaves 79, which multiplied by 1.4 is equal to 110.6, which is the quantity of ſaline matter in 1000 parts of the ſolution of common ſalt,

2243 Gaſeous bodies. 2. After aſcertaining the phyſical properties, the firſt ſtep in the analyſis is to eſtimate the quantity of gaſeous bodies which the water contains. Theſe are, oxygen gas, azotic gas, atmoſpheric air, ſulphurated hydrogen gas, and ſulphurous acid. They are to be collected by heating a quantity of the water in a retort, and receiving the gas over water, or over mercury, if it is abſorbed by water. The nature of the gas will be aſcertained by the different teſts which have been already mentioned for detecting the gaſes, and the quantity of it may be aſcertained, by calculating the bulk, taking care to make the proper allowance for the difference of preſſure of the air and temperature. But for this ſee Mr Kirwan's method of calculation, in his Eſſay on the Analyſis of Min. Wat. p. 178.

2244 Carbonates. 3. To diſcover the carbonates which may exiſt in the water, is the next ſtep in the analyſis. There may be carbonate of lime, of magneſia, of alumina, or iron. If the water contains ſulphurated hydrogen, it muſt be ſeparated by expoſure to the air, or by means of litharge. Filter and boil a quantity of the water for half an hour. In this way it is deprived of the earthy or metallic carbonates, if the water contains no ſulphurated hydrogen. It is to be boiled for a quarter of an hour, expoſed to the air till it is cool, and filtered. Diſſolve the precipitate in diluted muriatic acid. The whole are ſoluble in this acid, excepting alumina and ſulphate of lime. Let the reſiduum be expoſed to a red heat; mark the weight, and boil it in carbonate of ſoda. Saturate the ſoda with muriatic acid, and boil the mixture for half an hour. Carbonate of lime and alumina are thus precipitated. Diſſolve the dried precipitate in acetic acid. The lime is diſſolved, but the alumina remains. The weight of the lime, after being dried, ſubtracted from the original weight, gives the proportion of ſulphate of lime. To ſeparate the iron, add ammonia to the muriatic ſolution, as long as a reddiſh precipitate is perceived. If magneſia be precipitated with the iron, expoſe the precipitate in the open air for ſome time, to a heat of about 200°; add acetic acid in ſmall quantities, to diſſolve the magneſia; the iron thus ſeparated, is to be re-diſſolved in muriatic acid, precipitated by an alkaline carbonate, and gently dried and weighed. The acetate of magneſia is next to be precipitated and eſtimated as above. The muriatic ſolution is thus freed from iron and part of the magneſia. Add ſulphuric acid as long as any precipitate appears; heat the ſolution ſlightly, and add alcohol. The ſulphate of lime is ſeparated and heated to redneſs. A hundred grains are =70 of carbonate of lime. The ammonia is to be precipitated by carbonate of ſoda, dried and weighed. The whole of the carbonate of magneſia is not precipitated by boiling. Evaporate the boiled water nearly to dryneſs. The carbonate of magneſia and ſulphate of lime will be depoſited. Add a large quantity of boiling diſtilled water, which will diſſolve the ſulphate of lime, and other ſubſtances. The carbonate of magneſia remains behind, and may be collected, dried, and weighed. The carbonate of alumina and ſulphate of lime are to be eſtimated by weighing them, after they have been dried in a red heat.

2245 Sulphuric acid. 4. To aſcertain the proportion of ſulphuric acid, add barytic water to ſaturation, and weigh the precipitate after it has been expoſed to a red heat. A hundred parts of the ſulphate of barytes contain 33 of real ſulphuric acid. 2246 Muriatic. To determine the quantity of muriatic acid, likewiſe add barytic water, till it is neutralized, then precipitate the barytes with ſulphuric acid. A hundred parts of barytes take up 31.8 of

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* *Analyſis of Min. Wat.* p. 34.—142.

real muriatic acid. The proportion of boracic acid may be aſcertained by precipitating it with acetate of lead. The precipitate is to be digeſted in a heat

2247 Boracic.

of 200° for an hour with ſulphuric acid. Evaporate the ſolution to dryneſs, and add to the dried maſs 10 or 12 times its weight of alcohol. Diſtil and evaporate this ſolution; the boracic acid remains behind, which may be dried and weighed.

2248 Sulphate of ſoda.

5. The alkaline ſulphates are precipitated by means of nitrate of barytes. A hundred and ſeventy parts of ignited ſulphate of barytes indicate 100 of dried ſulphate of ſoda; and 136.86 of ſulphate of barytes indicate 100 of dry ſulphate of potaſh.

2249 Of lime.

6. Sulphate of lime is moſt conveniently determined by evaporating to a few ounces, and adding a few drops of alcohol, which will precipitate the ſulphate of lime. It is then to be dried and weighed. The proportion of alum in a mineral water is aſcertained by evaporating to one-half, and precipitating by means of carbonate of lime. Acetic acid added to the precipitate, combines with the exceſs of lime which may have been added. The alumina thus freed from the carbonate of lime, is to be heated to incandeſcence for half an hour. Twelve parts denote 100 cryſtallized alum, or nearly 49 of the dried ſalt.

2250 Of magneſia.

7. If no other ſulphate exiſts in the water, ſulphate of magneſia may be eſtimated by precipitating the acid with barytic ſalt. A hundred grains of ſulphate of barytes indicate 52.11 of ſulphate of magneſia. But if the water contains ſulphate of lime, without any other ſulphate, it may be decompoſed by means of carbonate of magneſia. The lime thus obtained being weighed, ſhews the quantity of ſulphate of lime. By adding barytes, the whole of the ſulphuric acid is precipitated, and thus the quantity of this acid may be eſtimated. Then by ſubtracting the quantity of ſulphuric acid belonging to the ſulphate of lime, the remaining portion indicates what was combined with the magneſia. If the water is found to contain ſulphate of ſoda, none of the earthy nitrates or muriates can exiſt along with it. If, therefore, no other earthy ſulphate has been detected, the magneſia is to be precipitated by means of ſoda, and is then to be dried and weighed; 36.68 parts indicate 100 of dried ſulphate of magneſia. If ſulphate of lime accompany theſe two ſulphates, the precipitate conſiſts both of lime and magneſia. It is then to be diſſolved in ſulphuric acid and evaporated to dryneſs. By adding twice its weight of cold water, the ſulphate of magneſia is diſſolved; the ſulphate of lime is inſoluble. Evaporate the ſulphate of magneſia to dryneſs, expoſe it to a heat of 400°, and weigh it. If the water contain alum inſtead of ſulphate of lime, the ſame proceſs may be followed. But the precipitate being dried, muſt firſt be treated with acetic acid to diſſolve the magneſia, but the alumina remains untouched. Sulphate of iron is ſeparated by expoſing the water to the air for ſome days, and then adding alumina. The iron is precipitated in the ſtate of oxide, and the ſulphate of alumina, being inſoluble, is precipitated at the ſame time. Theſe ſalts being previouſly ſeparated, the proportion of ſulphate of magneſia may be eſtimated in the way which has been already deſcribed.

2251 Of iron.

8. The proportion of ſulphate of iron may be eſtimated by the following proceſs. Let the weight of a precipitate formed with pruſſiate of potaſh in a ſolution of a known weight of ſulphate of iron in water, be previouſly aſcertained. Then with the ſame pruſſiate precipitate the ſulphate of iron in the water. But if muriate of iron has been detected in the water; evaporate to dryneſs, and add to the reſiduum alcohol, in which the muriate, but not the ſulphate, is ſoluble.

2252 Muriate of potaſh and ſoda.

9. Muriate of potaſh or of ſoda, unaccompanied with other ſalts, may be eſtimated by precipitating by means of nitrate of ſilver. 217.65 grains of muriate of ſilver denote 100 of muriate of potaſh; and 235 grains of muriate of ſilver denote 100 of muriate of ſoda. If the water contains any of the alkaline carbonates, they muſt be previouſly ſeparated by ſaturating with ſulphuric acid. The muriatic acid is then to be precipitated by ſulphate of ſilver. Muriate of ammonia is decompoſed by means of barytic water; the ammonia is expelled by boiling, the barytes is precipitated by ſulphuric acid, and the muriatic acid is ſaturated with ſoda. The ſulphate of barytes denotes the quantity of muriate of ammonia.

2253 Of lime, &c.

10. If the common ſalt be accompanied with muriate of lime, of magneſia, of alumina, or of iron, theſe may be precipitated with barytic water, and each earth waſhed, but not dried, re-diſſolved in muriatic acid. If only one of theſe ſalts be found, ſaturate the exceſs of acid with a known quantity of an earth of the ſame kind, and evaporate to dryneſs. Then deduct from the weight that of the muriate formed by the earth added: thus 50 grains of lime denote 100 of muriate of lime heated to redneſs; 31 grains of magneſia indicate 100 of muriate of magneſia; and 21.8 grains of alumina indicate 100 of muriate of alumina. The barytes is precipitated by ſulphuric acid; and the muriatic acid is driven off by heat. The muriate of ſoda may then be eſtimated by evaporation; but the proportion of muriate of ſoda, which the known quantity of muriatic acid ſeparated from the earths denotes, muſt be deducted.

If ſulphates and muriates are found accompanying each other, the former may be precipitated by alcohol, or by evaporating the whole to dryneſs. The earthly muriates may then be diſſolved in alcohol. Sulphate of lime, accompanying alkaline and earthy muriates, is decompoſed by muriate of barytes, and the precipitate of ſulphate of barytes indicates the proportion of ſulphate of lime.

If muriates of ſoda, magneſia, and alumina, accompany the ſulphates of lime and magneſia, the water to be examined is to be divided into two equal portions. To precipitate the whole of the lime and alumina, add to the one portion carbonate of magneſia. The proportion of lime in ſulphate of lime is then to be aſcertained; and, by precipitating the ſulphuric acid, by means of muriate of barytes, the quantity contained in the ſulphates of magneſia and of lime is aſcertained. The proportion of ſulphate of magneſia is determined by deducting this laſt portion. The whole of the magneſia and alumina is precipitated from the ſecond portion of water by lime water. The quantity of theſe earths indicates the proportion of muriate of magneſia and alumina, deducting that portion of magneſia which was diſcovered in the ſtate of ſulphate in the firſt portion of water. The ſulphuric acid is then precipitated by barytic water, and the lime by carbonic acid; the common ſalt is obtained by evaporating the water to dryneſs.

2254 Nitrate of potaſh.

11. Nitre may exiſt in water with all ſulphates and muriates which are not incompatible with each other. After ſufficient evaporation, the ſulphates are to be precipitated by acetate of barytes, and the muriates by acetate of ſilver. Filter and evaporate to dryneſs; and add to the reſiduum alcohol, which diſſolves the acetates. The nitrate of potaſh, which remains undiſſolved, may then be eſtimated. If ſoda be found in the water, it muſt be previouſly ſaturated with ſulphuric acid.

If nitre be accompanied with common ſalt, nitrate of lime, muriate of lime, muriate of magneſia, evaporate to dryneſs, and add alcohol, which diſſolves the earthy ſalts. Re-diſſolve the dry reſiduum in water, from which the nitre and common ſalt may be ſeparated by acetate of ſilver. Evaporate the ſpirituous ſolution to dryneſs, and re-diſſolve the reſiduum in water. The weight of muriate of magneſia is aſcertained by precipitating by means of nitrate of ſilver. The weight of the nitrate of lime is determined by precipitating by means of ſulphuric acid: 35 grains denote 100 of dry nitrate of lime *.

Chap. XVII. Of MINERALS.

In following out the arrangement which we have laid down at the beginning of this treatiſe, we ſhould now enter upon the conſideration of mineral ſubſtances. To preſerve the chemical inveſtigation of the different departments of nature unbroken, we propoſed to employ this chapter in a general view of the characters of mineral bodies, of their compoſition and methods of analyſis; but as this article has been unavoidably extended to ſo great a length, we ſhall reſerve the whole to the article Mineralogy, where they will be fully detailed.

Chap. XVIII. Of VEGETABLES.

2255 Diviſion of natural bodies.

1. Natural bodies may be properly divided into organized and inorganized, each of which exhibit characters ſufficiently diſcriminative. The ſubſtances included under the 17 preceding chapters, belong to the latter claſs. Organized ſubſtances are vegetables and animals, which are to be treated of in this and the following chapters. The diſtinction between theſe two claſſes of bodies, although in ſome caſes it is leſs obvious, in general is eaſily recognized. The moſt perfect forms of inorganized matter afford no marks of reſemblance to the varied and complicated ſtructure of a plant or an animal. In the mode of formation, or the growth and increaſe of the individuals of theſe two claſſes, there is the moſt ſtriking diverſity, which exhibits plain and certain characters of diſtinction. In the one claſs the growth or increaſe takes place by the mere aggregation of the particles of matter already prepared, and according to the laws of affinity between the particles; and no new properties exiſt in the aggregate, which did not exiſt in the minuteſt particle of which it is compoſed. The other claſs of bodies, comprehending vegetables and animals, exhibits a very different proceſs. The ſubſtances which enter into their compoſition are received into tubes or veſſels, are conveyed by them to every individual part of the vegetable or animal, are ſubjected to peculiar changes, and aſſume new forms, poſſeſſing properties and qualities which could not be previouſly detected in the ſimple elements, by any chemical or mechanical operation. This is indeed the eſſential characteriſtic of vegetables and animals. The particles which compoſe a cryſtal, formed by the evaporation of water, were held in ſolution by the water, and invariably and uniformly arranged according to certain laws; but the almoſt infinite variety of ſubſtances which compoſe vegetables and animals, are not to be found in the materials which are neceſſary to promote their growth and health; neither in the water, the earth, the air, the heat, nor the light, all which contribute their ſhare to the ſame end. Theſe undergo new changes, and enter into new combinations, none of which exiſted in the ſimple elements, and none of which can be effected by any mechanical or chemical proceſs. Indeed the laws which regulate vegetable and animal operations, ſeem to be totally different from the eſtabliſhed laws of chemical action. Hence, from obſerving this difference of action, the exiſtence and influence of a different principle have been inferred in animals and vegetables. This has been called the *vital principle*, or the principle of life, becauſe by its influence the varied and complicated phenomena of animals and vegetables are exhibited, which cannot be accounted for on mechanical or chemical principles. It is by the influence of this principle that the animal or vegetable ſeems to poſſeſs the remarkable power of reſiſting or counteracting to a certain degree the effects of chemical or mechanical agents which may prove injurious to its exiſtence; the power of regulating and ſelecting what is beneficial and neceſſary, of ſupplying what is deficient, and of curtailing what is redundant. Organized ſubſtances admit of a natural diviſion into vegetables and animals. The bodies included under each of theſe diviſions have ſome points of reſemblance; but in general are ſufficiently characterized and diſtinguiſhed from each other, by their form, ſtructure, power of motion, component parts and peculiarities of habits. The firſt of theſe diviſions, namely vegetables, forms the ſubject of the preſent chapter.

2256 Structure of plants.

2. A vegetable is compoſed of a root, ſtem, leaves, flowers, fruits, and ſeeds; and when all theſe different parts are fully developed, the vegetable is ſaid to be *perfect*. When any are deficient, or at leaſt leſs obvious, the vegetable is ſaid to be *imperfect*.

2257 Root.

The root is that part of the plant which is concealed in the earth, and which ſerves to convey nouriſhment to the whole plant. The ſtem, which commences at the termination of the root, ſupports all the other parts of the plant. When the ſtem is large and ſolid, as in trees, it is denominated the *trunk*, which is divided into the wood and the bark. The bark conſtitutes the outermoſt part of the tree, and covers the whole of the plant from the extremity of the roots to the termination of the branches. The bark is compoſed of three parts, namely, the epidermis, the parenchyma, and cortical layers. The epidermis, which is a thin tranſparent membrane, forming the external covering of the bark, is compoſed of fibres croſſing each other. When the epidermis is removed, it is reproduced. The

2258 Bark.

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* See *Anal. Min. Waters*, 175—258.

The parenchyma, which is immediately below the epidermis, is of a dark green colour, compoſed of fibres croſſing each other in all directions, and is ſucculent and tender. The cortical layers which conſtitute the interior part of the bark, are compoſed of thin membranes, and increaſe in number with the age of the plant.

2259 Wood. The wood immediately under the bark, is compoſed of concentric layers, which increaſe with the age of the plant, and may be ſeparated into thinner layers which are compoſed of longitudinal fibres. The wood next the bark, which is ſofter and whiter, is called the *alburnum*. The interior part of the trunk is browner and harder, and is denominated the *perfect wood*.

2260 Pith. In the middle of the ſtem is the pith, which is a ſoft ſpongy ſubſtance, compoſed of cells, or *utriculi*, as they are called. In old wood, this part entirely diſappears, and its place is occupied by the perfect wood. The leaves are compoſed of fibres arranged in the form of net-work, which proceed from the ſtem, and footſtalks by which they are attached to the branches. Theſe fibres form two layers in each leaf, which are deſtined to perform different functions. The leaves are covered with the epidermis, which is common to the whole of the plant. Each ſurface of a
2261 leaf has a great number of pores and glands, which
Flowers and fruits. abſorb or emit elaſtic fluids. Flowers are compoſed of different parts. The *calyx* or cup is formed by the extenſion of the epidermis; the *corolla* is a continuation of the bark, and the ſtamina and piſtilla, the internal parts of fructification, are compoſed of the woody fibres and pith of the plant. Fruits are uſually compoſed of a pulpy, parenchymatous ſubſtance, containing a great number of *utriculi* or veſicles, and traverſed by numerous veſſels. Seeds are conſtituted of the ſame utricular texture, in the veſicles of which is depoſited a pulverulent or mucous ſubſtance. Theſe cells have a communication with the plant by means of veſſels, and by theſe is conveyed the neceſſary nouriſhment during germination.

2262 Veſſels. Plants contain different orders of veſſels, which are diſtinguiſhed from each other by their courſe, ſituation, and uſes. Lymphatic veſſels ſerve for the circulation of the ſap. They are chiefly ſituated in the woody part of the plant. The peculiar veſſels, which generally contain thick or coloured fluids, are placed immediately under the bark; they are ſmaller in number than the ſap-veſſels, and have their interſtices filled up with utriculi or cells, with which they form a communication. Some of theſe proper veſſels are ſituated between the epidermis and the bark, which are readily detected in the ſpring. Some are ſituated in the interior part of the bark, forming oval rings, and filled with the peculiar juices of the plant. Another ſet of proper veſſels is placed in the alburnum, nearer the centre of the ſtock or trunk, and ſometimes in the perfect wood. The utriculi or cells conſtitute another ſet of veſſels, which ſeem to reſemble a flexible tube, ſlightly interrupted with ligatures at nearly equal diſtances, but ſtill preſerving a free communication through its whole length. They vary in form, colour, and magnitude, in different vegetables, and exiſt in the roots, the bark, leaves, and flowers. The tracheæ or ſpiral veſſels, which are readily detected in ſucculent plants, appear in the form of fine threads, and may be drawn out to a conſiderable length without breaking. Theſe veſſels are very numerous in all plants, eſpecially under the bark, where they form a kind of a ring, and are diſpoſed in diſtinct bundles, in trees, ſhrubs, and ſtalks of herbaceous plants.

After theſe preliminary obſervations on the characters of organized ſubſtances, and the general ſtructure of plants, we now proceed to give a ſhort view of the functions, decompoſition, and component parts of vegetables. Theſe ſhall form the ſubject of the three following ſections.

SECT. I. *Of the FUNCTIONS of VEGETABLES.*

I. Of Germination.

2263 Temperature. 1. When the perfect ſeeds of a vegetable are placed in certain circumſtances, they produce plants exactly ſimilar to thoſe from which they originated. The requiſite circumſtances for the germination of ſeeds are, heat, air, and moiſture. It is well known that no vegetation goes on when the temperature of the air is at the freezing point, and very little till it riſes a conſiderable number of degrees above it. The ſeeds of different plants, it is obſerved, require different degrees of heat for their germination, and hence the various ſeaſons and climates in which different plants and ſeeds are found to vegetate.

2264 Air. 2. But whatever the temperature may be, no ſeeds germinate, unleſs they are expoſed to the action of the air. It is found that it is the oxygen of the air which is neceſſary for the production of this change; for when it is entirely excluded no change takes place, and when it is in greater quantity, vegetation is more rapid and more vigorous.

2265 Moiſture. 3. Moiſture is alſo neceſſary for the vegetation of ſeeds. But although water be neceſſary for this purpoſe, it muſt be applied in moderate quantity, for, except the ſeeds of aquatic plants, which are poſſeſſed of peculiar habits, moſt ſeeds are deprived of their vegetative power, and entirely decompoſed, when they are kept in water. Hence it is that many ſeeds do not vegetate in ſtiff clay ſoils, which retain too much water, nor in ſandy ſands, which allow the whole of the water to filtre through them. Many ſeeds, although they are expoſed to the favourable action of theſe agents, do not vegetate when they are expoſed to the action of light. It is on this account, and alſo, no doubt, for the proper application of moiſture, that ſeeds are covered with the ſoil, by which means germination is found to be greatly promoted.

2266 Parts of ſeeds. 4. A ſeed is compoſed of three principal parts, which have been denominated the cotyledons or lobes, the radicle, and plumula. The greateſt number of ſeeds have two cotyledons. Some, however, as many of the farinaceous ſeeds, and ſeeds of graſſes, have only one. Other ſeeds have three, and ſome ſix. Hence plants have been diſtinguiſhed into *mono-cotyledinous*, *di-cotyledinous*, and *poly-cotyledinous*.

2267 Root formed. 5. The firſt change which takes place on a ſeed placed in circumſtances favourable to germination, is the increaſe of ſize by the abſorption of moiſture. The radicle is then formed, which ſtretches downwards into the earth. The plumula ſhoots upwards, and expands into leaves and branches. The peculiar function of the root is to convey nouriſhment from the earth for the future growth of the plant; but from what ſource is the nouriſhment derived for the formation of the root itſelf?

2268 Oxygen abſorbed.

6. The very firſt change which takes place within the ſeed is the combination of the oxygen of the air which is abſorbed, with the carbone which exiſts in the lobes of the ſeed, and the formation of carbonic acid, which is given out in the ſtate of gas. The farinaceous matter of the ſeed being deprived of part of its carbone, is converted into a ſaccharine ſubſtance, which is deſtined for the nouriſhment of the embryo plant, till its parts are ſo far evolved, and its ſtructure ſo completed, as to derive nouriſhment from the earth.

2269 Carbonic acid gas emitted.

7. The firſt chemical change, therefore, which is obſerved in the germination of ſeeds, is the abſorption of oxygen, the emiſſion of carbonic acid gas, and the converſion of the farinaceous matter into a ſaccharine ſubſtance. This is the proceſs of germination, as it has been deſcribed by chemical phyſiologiſts. But if oxygen gas be entirely excluded, no change takes place; no part of the proceſs of germination goes on; or even if it has proceeded ſo far as that the plumula ſhall have appeared above the ſurface in the form of ſeminal leaves; if theſe leaves are removed before others have been unfolded, the plant dies. The ſeminal leaves are the lobes which have been puſhed out of the earth along with the plumula, ſo that if they are deſtroyed the plant is cut off from the neceſſary ſource of nouriſhment for the evolution of its parts, and the formation of roots and leaves, which are deſtined to perform the different functions of vegetation.

II. Of the Food of Plants.

2270 Suppoſed to be water.

1. But air, heat, and moiſture are not only neceſſary for the formation of the different parts of the plant; their action muſt be continued, and are abſolutely requiſite for its future health and growth. It could not long eſcape obſervation, that plants ceaſe to vegetate when they are entirely deprived of water. Hence it became the opinion of the earlier phyſiologiſts, that water conſtituted the chief or the only food of plants; but it
2271 Not pure. has been proved by experiments in analyzing plants which grew in pure water, that they received no increaſe of one of the neceſſary principles in their conſtitution, farther than what previouſly exiſted in the ſeeds or roots from which they ſpring. In a ſeries of experiments inſtituted by Haſſenfratz, on the roots of hyacinths, the ſeeds of kidney beans and other ſeeds, he found that the quantity of carbonaceous matter in the full-formed plant, was even leſs than what previouſly exiſted in the bulb or ſeed.

2272 Is the ſolvent of the food.

2. But although pure water ſeems not to contribute to the growth of plants, yet it is neceſſary as a ſolvent for thoſe ſubſtances which are conſidered as the proper food of vegetables. But when water is impregnated with certain ſaline and earthy, but eſpecially with carbonaceous matter, it is then found to be moſt proper for promoting the growth and increaſe of vegetables. We have obſerved plants growing in a ſoil which was frequently moiſtened with the water from a dunghill, advance with a more rapid and vigorous growth, and attain to a larger ſize, than ſimilar plants in the ſame ſoil, which received only the uſual ſupply of rain and dew from the clouds. It has been found by experiment, that this water holds in ſolution a conſiderable portion of carbone. It is not improbable that it alſo contains ſome of thoſe ſaline matters which have been detected by analyſis in plants in the greateſt health and luxuriance. The waſte of the ſoil muſt be repaired with frequent additions of manure, which may be conſidered as neceſſary ſupplies of food or nouriſhment.

2273 Peculiar ſtructure of the root.

3. But whatever may be the food of plants, it is taken up by the roots in the ſtate of ſolution in water, and conveyed by the veſſels to every part of the vegetable. For this purpoſe it would appear that there is a peculiarity of ſtructure in the extremities of the roots; for, if part of the fibre of a root be cut off, the plant ceaſes to vegetate till new fibres are formed, which are ſo conſtructed, as to be capable of abſorbing the neceſſary quantity of water.

2274 Sap.

4. This fluid, which is found in plants, is called the *ſap*. It is moſt abundant in the ſpring, as the ſeaſon of vegetation advances; and during that ſeaſon, when the plant is wounded, it flows out copiouſly, and it is then ſaid *to bleed*. This is particularly the caſe with ſome trees, ſuch as the birch and a ſpecies of maple; the ſap of which, by certain proceſſes, yields wine or ſugar. The ſap is contained in what is called the *lymphatic* or common veſſels of the plant.

2275 Is prepared in the plant.

5. The fluids taken up by vegetables, it is probable, no ſooner enter the plant, than they undergo ſome change. Vauquelin has directed his attention to this ſubject, and has analyzed the ſap at different periods during the ſeaſon of vegetation.
2276 Sap of the elm. The ſap of the common elm (*ulmus campeſtris Lin.*) extracted from the tree early in the ſpring, was of a brown colour, had a ſweet, mucilaginous taſte, but ſcarcely reddened the tincture of turnſole. Ammonia produced in this fluid a copious yellow precipitate, ſoluble with effervеſcence in acid. Barytes and lime-water produced a ſimilar effect. Oxalic acid and nitrate of ſilver gave a white precipitate. Sulphuric acid, diluted with water, occaſioned a briſk effervеſcence, with the evolution of the odour of acetic acid from the mixture. Oxymuriatic acid deſtroyed the colour of the ſap, and formed in the liquid a yellow precipitate.
2277 Experiments. Hydroſulphuret of potaſh and ſulphate of iron effected no change, but alcohol threw down a flaky precipitate. A quantity of this ſap being evaporated with a moderate heat, there was found on the ſurface a browniſh pellicle; a brown matter ſeparated in the form of flakes, and an earthy matter depoſited on the ſides of the veſſel, which was dry to the touch. After evaporation to a certain degree, and cooling, a yellow earth was depoſited, which diſſolved with effervеſcence in muriatic acid. When the ſolution was completed, the liquid was filtered, to ſeparate the inſoluble vegetable matters. The muriatic ſolution mixed with carbonate of potaſh, yielded carbonate of lime. The liquid which had depoſited the vegetable matter being evaporated with a gentle heat afforded a grayiſh extract, which ſtrongly attracted moiſture from the air, and had a very pungent, ſaline taſte. It effervеſced with the addition of concentrated ſulphuric acid, and gave out the odour of radical vinegar. Diſtilled with three parts of ſulphuric acid, it furniſhed very concentrated acetic acid, and there remained in the retort ſulphate of potaſh with exceſs of acid.

6. From this analyſis it follows, that the extract of the

ſap of the elm is chiefly compoſed of acetate of potaſh. One thouſand and thirty nine parts of this ſap yielded nearly the following proportions.

2278 Compoſition.

Acetate of potaſh	9.240
Vegetable matter	1.060
Carbonate of lime	.796

The deficiency was made up of water and ſome volatile matter.

When the ſeaſon was farther advanced, the ſap of the ſame tree was again ſubjected to analyſis, and it was found that the quantity of acetate of potaſh and carbonate of lime had diminiſhed, but that the quantity of vegetable matter was nearly double. At a ſtill more advanced period of the ſeaſon, the experiment was repeated, the reſult of which was, that the increaſe of the vegetable matter, and the diminution of the acetate of potaſh and carbonate of lime were ſtill greater. It appeared too, that carbonic acid exiſted in exceſs in the ſap, and that the carbonate of lime was held in ſolution by it.

2279 Of the beech.

7. The ſame chemiſt analyzed the ſap of the beech, and it was found to be compoſed of water, acetate of lime with exceſs of acid, acetate of potaſh, gallic acid, tan, mucus, extractive matter, and acetate of alumina; but the proportions of theſe parts have not been mentioned. From this analyſis it appears, that the ſap of the beech is different from that of elm, in containing acetic acid uncombined, beſides gallic acid and tan, but at the ſame time having no carbonate of lime. When the ſap of the ſame plant was examined later in the ſeaſon, the proportion of gallic acid and tan had increaſed. Vauquelin alſo examined by analyſis, the ſap of the carpinus ſylveſtris or hornbeam, and the betula alba or birch *. The component parts of the ſap of the former were found to be, acetate of potaſh and lime, mucilage, ſugar, and extract, with water; and the latter were found to be water, acetates of lime, alumina and potaſh, ſugar, and vegetable extract. From theſe experiments it appears that the fluids which are taken up by plants, are immediately changed by certain proceſſes within the plant; for ſome of the ſubſtances which are component parts of the ſap of plants, are either not found in the liquids before they enter the plant, or exiſt in them in very ſmall quantity. Theſe changes, it appears too, from the ſame experiments, are conſiderably greater, at the later periods of the ſeaſon of vegetation. Some of the component parts are greatly increaſed, while others are much diminiſhed.

2280 Of the hornbeam.

2281 Aſcends through the wood.

8. The ſap aſcends from the root to the extremities of the branches, which has been proved by making inciſions in the trunk of a tree at different heights in the ſpring ſeaſon. The ſap is obſerved to flow, firſt, from the loweſt inciſion, and ſucceſſively to the higheſt. It is through the veſſels in the woody part of the tree, that the ſap aſcends, for no ſap flows from an inciſion unleſs it has penetrated the wood, and in ſome trees it is neceſſary to make the inciſion nearly to the center. It has been obſerved that coloured infuſions always paſs from that part of the wood called the alburnum.

2282 By the tracheæ.

9. The ſap of plants is conveyed through thoſe veſſels which were deſcribed under the name of *tracheæ* or ſpiral veſſels. Theſe were denominated tracheæ or air-veſſels by the earlier phyſiologiſts, becauſe being found empty, when they were cut acroſs and examined, they were ſuppoſed to convey nothing but air.

2283 Cauſe of the aſcent.

9. As the ſap of vegetables moves with very conſiderable force, it has given riſe to much ſpeculation about the nature of that power, or the cauſe by which this is effected. Malpighi aſcribed the aſcenſion of the ſap to the dilatation and contraction of the air in the air-veſſels; while Grew ſuppoſed, that it was owing to the lightneſs of the vapour, in which ſtate he conceived the ſap entered the plant, and was conveyed through it. By many others the aſcent of the ſap in vegetables has been aſcribed to the force of capillary attraction; but the nature of this action, as it is demonſtrated and explained by mechanical philoſophers, ſeem to be incompatible with the phenomena of the circulation of the ſap in vegetables, and has therefore been rejected as a hypotheſis equally unſatisfactory with thoſe which have been juſt mentioned. It has been aſcribed with more probability to the action of the veſſels themſelves. This is owing, in the language of phyſiologiſts, to the irritability of the veſſels, or a certain power by which they are enabled to contract, by the action or influence of certain ſubſtances. This is ſuppoſed to be the caſe with the ſap, and the action which takes place when it enters the roots, is owing to the irritability of the veſſels. As the ſap is carried a certain length by the firſt contraction, it is carried ſtill farther by the ſecond; and thus by ſucceſſive contractions it is propelled through every part of the plant, while at the ſame time new additions continue to enter the extremities of the root.

III. Of the Functions of the Leaves.

1. Whatever be the nature of the proceſs, the ſap is carried to every part of the vegetable, and we have ſeen that it has no ſooner entered it than it undergoes certain changes, which become more conſiderable according to the length of time after its abſorption. But the greateſt changes which take place in the ſap of plants, are effected in the leaves. The leaves are to be conſidered among the eſſential organs of vegetables, for in them the ſap is totally changed, and converted into the peculiar juice, or *ſuccus proprius*, of the plant. As the functions of the leaves are of great importance in vegetation, it will be neceſſary to conſider the nature of their action.

2284 Produce great changes on the ſap.

2285 Convert it into the peculiar juice.

2286 During the day.

2. During the day, the leaves of plants tranſpire a very conſiderable quantity of moiſture, the proportion of which, it appears from ſome experiments, was not much inferior to the quantity abſorbed. From ſimilar experiments it appears that the quantity evaporated was in proportion to the extent of ſurface of the leaves. The quantity has been obſerved to be greateſt too, during ſunſhine and warm weather. It is greatly interrupted during the night, and entirely checked by cold. When the quantity of moiſture tranſpired is diminiſhed, the moiſture imbibed is alſo found to be leſs in proportion. This indeed might have been expected, for when the tranſpiration of a plant ceaſes, this being an eſſential function of vegetation, the whole proceſs muſt be interrupted. In experiments made on this tranſpired matter, by evaporating to dryneſs a quantity which had been collected, a ſmall portion of carbonate of lime was obtained; from the reſiduum,

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* Ann. de Chim. xxxi. 20.

a ſtill ſmaller proportion of ſulphate of lime, with a little gummy and reſinous matter. It has been found that the tranſpiration of moiſture takes place chiefly on the upper ſurface of the leaves, and this ſeems to be performed by a particular ſet of organs.

2287 Oxygen gas given out. 3. During the day, and eſpecially during bright ſunſhine, oxygen gas is given out by the leaves of plants. 2288 Carbonic acid gas abſorbed. The quantity of oxygen gas emitted by leaves, as appears from the experiments of naturaliſts, depends on the quantity of carbonic acid gas which is abſorbed by the plant; for it has been aſcertained that vegetables grow rapidly and vigorouſly when they are expoſed to this gas; nay, it is found eſſentially neceſſary to their health and growth. If the water with which plants are ſupplied be deprived of the whole of its air by boiling, no oxygen gas is emitted, and water which is impregnated with the greateſt proportion of carbonic acid gas, gives out the greateſt quantity of oxygen gas.

2289 Action of light. 4. This proceſs goes only during the day, and it is more vigorous during bright ſunſhine; from which it is natural to conclude, that light performs ſome neceſſary part in it. It is well known that plants which grow in the dark do not acquire a green colour; and it is found that theſe plants contain a ſmaller proportion of carbone than ſimilar plants, in the ſame circumſtances, expoſed to the light. From this it may appear what is the nature of the proceſs when carbonic acid gas is abſorbed by plants, and oxygen gas emitted. It is the decompoſition of the former, which is effected; the carbone being retained in the plant, and the oxygen given out; but light being a neceſſary agent in this decompoſition, the proceſs muſt be interrupted when it is excluded.

2290 Parenchyma of the leaf gives out the oxygen gas. 5. This decompoſition takes place in the parenchymatous ſubſtance of the leaf, and the quantity emitted, it appears, is in proportion to the thickneſs of this ſubſtance. The green colour of plants, it has already been mentioned, depends on the action of light. Plants which vegetate in the dark, have not only a ſmaller proportion of carbone, but alſo continue of a white colour; but in a ſhort time after they are expoſed to the light, the green colour is reſtored.

6. Thus it appears, that it is one part of the functions of leaves of plants to exhale a conſiderable proportion of the moiſture taken in by the roots; to abſorb carbonic acid gas; to decompoſe this gas, by which its carbone is retained in the plant, and the 2291 Vegetables the great ſource of oxygen. oxygen is given out. Thus too, it appears, that vegetables are one of the great ſources of ſupply of oxygen gas, which is eſſentially neceſſary in the numerous proceſſes of combuſtion, and the reſpiration of animals, which are conſtantly going on on the ſurface of the earth; and thus the waſte of this vital fluid is repaired, and the balance preſerved between its deſtruction and ſupply.

2292 Function of leaves during the night. 7. The leaves of plants perform a very different function during the night. Inſtead of emitting moiſture and oxygen gas, and abſorbing carbonic acid gas, which takes place during the day, the proceſs is reverſed. Carbonic acid gas is emitted, and moiſture and oxygen gas are abſorbed. The abſorption of moiſture ſeems to be chiefly performed by the under ſurface of the leaves, at leaſt in many plants. It has been found by experiment, that plants, which have been made to grow in oxygen gas give out a greater quantity of carbonic acid gas, than when they grow in common air. From this circumſtance it has been ſuppoſed, that the carbonic acid gas, emitted by plants during the night, is owing to the combination of the oxygen abſorbed, with the carbone of the ſap; for it is at the ſame time that oxygen is abſorbed. It has alſo been aſcribed to the decompoſition of the water.

8. By theſe different proceſſes which are carried on in the leaves of plants, by the abſtraction of ſome of its principles, and by entering into minute combinations with others, the ſap undergoes very great changes. 2293 Peculiar juice. It is there converted into the peculiar juice of the plant, from which are derived, by other proceſſes, the different ſubſtances, which are produced in the different parts of plants, the nature of which will be afterwards examined. The leaves of plants have been compared to the lungs and ſtomach of animals. How far this analogy is juſt, it is not neceſſary to inquire; but there can be no doubt that the leaves are eſſential organs in the economy of vegetables. In the very firſt ſtep in the proceſs of vegetation, during the germination of ſeeds, the moiſture abſorbed by the roots is carried to the ſeminal leaves, and there undergoes certain changes, before it is fit for the formation of the ſtem and other leaves of the plant; for, if theſe leaves are removed, vegetation is entirely interrupted, and the plant dies. Even when plants have made farther progreſs, and are in full vigour, if they are entirely ſtripped of their leaves, the powers of vegetation ceaſe, till theſe neceſſary organs are reſtored, and new leaves are formed. The progreſs of vegetation is alſo ſtopped when the ſurface of leaves is varniſhed over, ſo that the abſorption and emiſſion of the neceſſary fluids are interrupted.

2294 Sap flows from the roots to the leaves. 9. The ſap of plants, it has been already obſerved, flows from the roots towards the branches and leaves of the plant. In the leaves it undergoes peculiar changes, in conſequence of part being exhaled, and in conſequence of the abſorption of different principles which combine with it, and no doubt contribute by this combination to the changes which take place. The ſap, as we have already ſaid, is then converted into the *ſuccus proprius*, or peculiar juice. It is the ſap of the plant, which is ſo far prepared to be converted into the different parts of the plant, correſponding to its nature and properties; and, as the different parts, both of liquids and ſolids in plants, poſſeſs properties totally diſtinct from each other, and have derived theſe from the ſame nouriſhment, the proceſſes by which theſe different ſubſtances are produced in different plants, and even in the ſame plant, muſt undoubtedly be different.

2295 Peculiar juice from the leaves to the roots. 10. The peculiar juice of plants flows from the leaves towards the roots. If a ligature is faſtened round the ſtem of a plant, the place immediately above the ligature, that is, between it and the leaves, ſwells out by the accumulation of this juice. Or if a wound be made in the bark, the peculiar juice flows in greater abundance from that ſide of the wound next to the leaves, than from the other ſide.

2296 Properties of it. 11. The peculiar juice of plants has a greater conſiſtence than the other juices. It is readily recognized by ſome peculiarity of colour. In a great many plants it is milky, in ſome it is of a green colour, and in others it is red. The component parts of the peculiar juice of plants are little known, but from ſome experiments which have been made on this ſubject, it appears that ſome part of the vegetable is ready formed. In the experiments of Chaptal on the peculiar juice of plants, he detected a ſubſtance which poſſeſſed the properties of the woody fibre. In ſimilar experiments on the ſeeds of plants, it was found that they contained a greater proportion of the woody fibre, from which it is inferred, that the peculiar juices of plants contain their nouriſhment ready prepared, and in that ſtate in which it is found in the ſeed. The peculiar juices of plants contain a greater proportion of theſe elements which conſtitute the different parts of plants, than what is found to exiſt in the ſap. Theſe are carbone, hydrogen, and oxygen.

2297 Plants have different periods of duration.

12. Many plants ceaſe to vegetate as ſoon as they have perfected their ſeeds, which is accompliſhed by ſome in one ſeaſon, by others in two, and hence ſuch plants have been called *annuals* and *biennials*. Other plants, however, continue to yield ſeeds and fruit for many ſucceſſive ſeaſons, and to live for a great length of time. What is the cauſe of this remarkable diverſity among the vegetable tribes,—why the humble annual ſprings up, flowers, and forms perfect ſeeds within the ſhort period of a few months, while the ſtately oak rears its lofty head, and continues to be the pride and glory of the foreſt for hundreds of years, it would be difficult to ſay. At preſent, however, it is not our province to enter into the ſpeculation.

Sect. II. *Of the Decompoſition of Vegetables.*

1. As ſoon as plants have ceaſed to vegetate, they undergo a new ſet of changes. The whole plant is broken down; the elements of which it is compoſed enter into new combinations, and new ſubſtances make their appearance, which did not previouſly exiſt in the plant. This decompoſition is owing, partly to the affinities between the component parts of the vegetable themſelves, and partly to the affinities which exiſt between ſome of the elementary principles of the plant, and the heat, air, and moiſture, without which no decompoſition takes place. While the plant continued to exhibit the phenomena of vegetation, that is, while it continued to live, it poſſeſſed a power of reſiſting this chemical action between the elements of which it is compoſed, and alſo to a certain extent the action of external agents. During this decompoſition of vegetables, air, heat, and moiſture, are neceſſary. Gaſeous bodies are generally given out, and new compounds are formed. Some plants, and ſome parts of the ſame plant, have a greater tendency to undergo this decompoſition than others, becauſe they either poſſeſs a greater proportion of the ſubſtances which promote the decompoſition, or a greater proportion of the ſubſtances of which the new compounds are formed.

2298 Fermentation.

2. The changes or ſpontaneous decompoſitions of vegetables, as they are almoſt always accompanied with an inteſtine motion, have received the name of *fermentation*. The nature of theſe changes is very different, both with regard to the gaſeous bodies which are abſorbed or emitted, and the nature of the products which are obtained after the proceſs is finiſhed. Hence, fermentations have been uſually diſtinguiſhed into three kinds; namely the *vinous*, ſo called, becauſe the product is wine, when certain ſubſtances are ſubjected to this proceſs, or beer, when other ſubſtances are employed; the *acetous* fermentation, becauſe during this part of the proceſs vinegar is produced; and the *putrid* or *putrefactive* fermentation, becauſe the ſubſtances are ſtill farther decompoſed, and run into the ſtate of putridity. But theſe different kinds of fermentation might perhaps be conſidered merely as different ſtages of the ſame proceſs; for unleſs it is checked at certain periods, it runs on through the different ſtages without interruption. According to ſome, theſe three ſpecies of fermentation do not include all the changes which have the characters of this proceſs to which vegetables are ſubject. To theſe it has been propoſed to add the ſaccharine fermentation, or that change which is induced on farinaceous ſeeds by heat and moiſture, which is the germination of ſeeds or the proceſs of malting; and the colouring fermentation, or that proceſs by which the colouring matter of vegetables, as indigo, is developed. In the preſent ſection we propoſe to treat, 1. Of the vinous fermentation; 2. Of the acetous or acid fermentation; 3. The panary fermentation, or the formation of bread; and, 4. Of the putrid fermentation.

2299 Four kinds.

I. Of the Vinous Fermentation.

2300 Hiſtory.

1. The vinous fermentation, otherwiſe denominated the ſpirituous, has been ſo called, becauſe the firſt product is wine, which by diſtillation yields ſpirits. Boerhaave was the firſt who directed his attention to trace the cauſes, and to obſerve the phenomena of fermentation. The ſame ſubject was afterwards proſecuted by other chemiſts, and much was written on the nature and manufacture of wine; but till the diſcoveries of modern chemiſtry, and eſpecially the important one of the compoſition of water, nothing was aſcertained with preciſion concerning the nature of fermentation, or the changes which take place on the fermenting ſubſtances. To the experiments and reſearches of Lavoiſier on the formation and decompoſition of alcohol, chemiſtry is indebted for ſome of the moſt important facts with regard to the proceſs of fermentation.

2301 Conditions.

2. Certain conditions are neceſſary to promote the vinous fermentation. The firſt indiſpenſable condition is the preſence of ſome ſaccharine matter. Experience has ſhewn that no vegetable ſubſtances are ſuſceptible of this fermentation, which do not contain ſugar. Thus, the ſweet juices of fruits are uſually employed in this proceſs; and particularly, for the production of wine, the juice of the grape.

But ſugar in a ſtate of purity, or uncombined with other ſubſtances, is not ſuſceptible of any change. A certain quantity of water, therefore, is neceſſary that the ſaccharine matter may be in the liquid ſtate. Water, therefore, is one of the eſſential conditions of the vinous fermentation; and it ſeems neceſſary that the water ſhould neither be in too great quantity, nor deficient. In the latter caſe the fermentation is interrupted; in the former it is promoted too rapidly, and is apt to be converted into the next ſtage, the acetous or acid fermentation. When the conſiſtence is too great, water muſt be added, and when it is too fluid, the addition of ſugar becomes neceſſary.

The vinous fermentation ſcarcely commences, if the temperature be below 60°, but at the temperature of 70° the proceſs goes on briſkly.

But ſugar and water alone do not ferment, without the addition of ſome other ſubſtances. In the liquid expreſſed from grapes, which has received the name of *muſt*, there are, beſides ſugar, a portion of jelly, ſome glutinous matter, and tartar.

The contact of air has been conſidered as one of the requiſites of the vinous fermentation; but this is not neceſſary, on account of the fermenting liquid deriving any addition from the atmoſphere, for the proceſs goes on equally well, when it is excluded, provided the gaſeous bodies which are formed are permitted to eſcape.

A large maſs is alſo favourable for promoting the vinous fermentation. A ſmall quantity of ſaccharine matter ſcarcely at all undergoes this change, while it runs ſpeedily to the acid fermentation.

2302 Phenomena of fermentation. 3. When the ſubſtances which are ſuſceptible of this fermentation, are placed in proper circumſtances, the proceſs commences in a few hours, or a few days, according to the temperature and the quantity of liquid employed. The liquid is then agitated with an inteſtine motion; it becomes thick and muddy; the temperature increaſes, and carbonic acid gas is diſengaged. The liquid is increaſed in bulk, and the ſurface is covered with a voluminous, frothy matter, which is owing to the carbonic acid gas adhering for ſome time to the viſcid matters in the liquid. The quantity of carbonic acid gas diſengaged during this proceſs is very conſiderable. It begins to be evolved at the commencement of the fermentation, and continues till its termination. At the end of a few days, or a longer or ſhorter time, according to the temperature and other circumſtances, the fermentation ceaſes. The liquid becomes tranſparent, the matters which occaſioned the muddineſs having precipitated to the bottom, and from having a ſweet taſte, it becomes ſharp and hot, and from having been viſcid and glutinous, it becomes more liquid and lighter. It is now converted into wine.

2303 Decompoſition of the ſugar. 4. Such are the phenomena of fermentation, from which, and from the nature of the product, very conſiderable changes muſt have taken place on the component parts. One change has been obſerved during this proceſs; namely, that the quantity of ſugar is always diminiſhing, and, at the end of the proceſs, is entirely decompoſed. The liquid is now more fluid, is ſpecifically lighter, and has obtained a vinous taſte; which new properties are aſcribed to the formation of alcohol which exiſts in all wine. It would appear, from the experiments of M. Lavoiſier, that it is the ſugar only which has ſuffered decompoſition. It is divided into two portions, one of which ſeparates, and is carried off in the form of carbonic acid gas, while the other, containing a greater proportion of hydrogen, remains in the liquid, in the form of alcohol. Part of the alcohol is carried off, and the alcohol which remains in the liquid is combined with the acids of the wine and the colouring matter, from which it muſt be ſeparated by diſtillation. The tartarie acid, it has alſo been found, is partially decompoſed during the proceſs, and a portion of malic acid is formed. It appears from other experiments, that azotic gas is diſengaged during this proceſs, from which it is inferred, that ſome others of the conſtituents of the fermenting liquid have been decompoſed, ſince ſugar contains no azote.

2304 Component parts of wines. 5. There is great variety in the colour, flavour, and ſtrength of wines. Theſe differences depend on the nature of the ſoil and of the grapes, and very often on the manner in which it is manufactured. But the component parts of wine are generally ſome acid matter, alcohol, extractive matter, oil, and colouring matter. It has been aſcertained by experiment, that all wines redden the tincture of turnſole. The acid which exiſts in greateſt abundance in wine, was found by Chaptal to be the malic acid; ſome portion of citric acid alſo has been detected. Some wines, as champaigne, contain a conſiderable portion of carbonic acid.

It is to a certain portion of alcohol contained in wines that they owe their ſtrength; and, when wines are ſubjected to the proceſs of diſtillation, the alcohol paſſes over, and the ſpirit which is thus obtained is known by the name of *brandy*.

2305 Extractive matter. The extractive matter found in wines has been obſerved to diminiſh in proportion to the age of the wines, as it ſeparates gradually from the liquid, and is precipitated to the bottom.

2306 Volatile oil. The flavour and odour of wines have been aſcribed to a ſmall quantity of volatile oil; but this quantity is ſo ſmall, that no means hitherto employed have ſucceeded to obtain it in a ſeparate ſtate. Wines are diſtinguiſhed by a peculiar colour, which is owing to the colouring matter originally derived from the huſk of the grape.

2307 From other ſubſtances. 6. The juices of other fruits alſo afford materials for fermentation, as that of cyder from apples, and perry from pears. Theſe are diſtinguiſhed from wines properly ſo called by containing a greater proportion of mucilaginous matter. The juice of the ſugar cane alſo affords a fermenting liquid from which is obtained by diſtillation the ſpirit called *rum*.

2308 Beer. 7. Beer or malt liquors, as they are called in Britain, are fermented liquors obtained from farinaceous ſeeds. Different kinds of corn are employed for the purpoſe of making beer. In Britain, barley is the moſt common grain in the preparation of this liquid. It is firſt ſteeped in water, and afterwards thrown together in a heap for about 24 hours. During this period, in conſequence of the moiſture which has been abſorbed by the grain, the proceſs of germination commences, oxygen gas is abſorbed, carbonic acid gas is given out and heat is evolved, while the radicle is protruded. The proceſs having advanced thus far, is checked by ſlowly drying the grain. For this purpoſe it is ſpread out on a floor, and in this ſtate it is known by the name of malt. It is afterwards expoſed to heat, fully dried, and ground to a coarſe powder. An infuſion is then made with water about the temperature of 160°, which is drawn off; more water is added till the whole ſoluble part of the malt is extracted. This infuſion, which has a ſweet taſte, from having a portion of ſaccharine matter, is called *wort*. After being boiled with ſome bitter ſubſtances, as hops, it is allowed to ferment, and the proceſs of fermentation is in a great meaſure ſimilar to that which has been already deſcribed of the fermentation of wine. The temperature moſt proper for this fermentation is about 60°; the fermentation of wort is greatly promoted, and the quantity of the fermented liquor is more abundant with the addition of yeaſt.

2309 Fermentation goes on in cloſe veſſels. It has been found alſo, that the infuſion of malt ferments in cloſe veſſels, and equally well as when expoſed to the open air. During this fermentation carbonic acid gas is diſengaged, which is mixed with a portion of the wort. By the diſtillation of the liquid obtained after the fermentation has ceaſed, alcohol is obtained; the nature and properties of which have been already deſcribed in treating of that liquid under inflammable ſubſtances.

II. Of the Acetous Fermentation.

1. In treating of acetic acid, which is the product of this fermentation, we have already detailed the method propoſed by Boerhaave for the manufacture of vinegar, and we have alſo deſcribed the properties of that acid. All that is now neceſſary, therefore, is ſhortly to ſtate the general phenomena which are exhibited during this fermentation. 2310 Phenomena. When wine or beer, which is the product of the vinous fermentation, is expoſed to a temperature between 70° and 90°, it becomes gradually turbid, the temperature is increaſed; it is agitated with inteſtine motions, and flaky ſubſtances are ſeen floating through it in all directions. The inteſtine motions at laſt ſubſide, the liquid becomes tranſparent by the matters which rendered it turbid precipitating to the bottom of the veſſel. The liquid has now aſſumed different properties; it is converted into acetic acid or vinegar.

2311 Conditions. 2. The conditions neceſſary for the acetous fermentation are, a conſiderable elevation of temperature, and expoſure to the air of the atmoſphere. During this fermentation oxygen is abſorbed from the air, and unleſs this abſorption takes place, the fermentation does not go on. It is neceſſary that the ſubſtances to be ſubjected to this fermentation contain a certain proportion of extractive matter; for if they are entirely deprived of it, the proceſs does not go on. Weak wines or beer are more readily converted into vinegar than ſtrong wine; but when the proceſs of fermentation has commenced on the latter, the product is a ſtronger and better vinegar.

2312 Changes. 3. In examining the products of this fermentation it has been found that the malic acid and the alcohol which previouſly exiſted in the wine, have entirely diſappeared, ſo that by their decompoſition they have contributed to the formation of the vinegar. Some portion of the extractive matter alſo has been decompoſed. The acetic acid is formed alſo during the decompoſition of many vegetable ſubſtances, either by means of heat, or other chemical agents.

III. Of the Panary Fermentation, or of Bread.

2313 Nature of this fermentation. 1. The fermentation which takes place in making bread is ſuppoſed to be peculiar; but the phenomena and product have not been ſufficiently examined to be able exactly to aſcertain its nature. The proceſs is extremely ſimple. Wheat flour, which is generally employed, is formed into a paſte with water, the proportions of which vary according to the age and quality of the flour. After ſome time it is agitated with an internal motion, ſimilar to the other fermentations, in conſequence of the action of the component parts upon each other, the formation of new compounds, and the evolution of gaſeous matter. Water is eſſentially requiſite in this fermentation. One of the changes which have taken place during the proceſs, is, that the gluten which conſtitutes a part of the flour, has diſappeared. It is entirely decompoſed. This matter has acquired a ſour diſagreeable taſte, and if it is made into bread, it is found unfit to be eaten.

2314 Leaven. A quantity of new paſte is then prepared, and a ſmall quantity of the old ſour paſte is added to it. This produces rapid fermentation. The ſour paſte thus added, to promote the fermentation, is called *leaven*, and the bread prepared by this proceſs has received the name of *leavened bread;* a diſtinction which has been known to mankind from the earlieſt ages of the world. It is frequently mentioned in Scripture, in the Jewiſh hiſtory. It requires ſome attention to be able to determine the exact quantity of leaven neceſſary for the proper fermentation of the paſte. When it is deficient in quantity, the proceſs of fermentation is interrupted, and the bread thus prepared is ſolid and heavy, and if too much leaven be uſed, it communicates to the bread a diſagreeable ſour taſte. When the fermentation ſucceeds, the paſte ſwells up, and is greatly enlarged in bulk, which is owing to the formation of a quantity of gas, which is confined within the maſs, by the viſcidity of the glutinous part of the flour.

Other ſubſtances are employed to promote the fermentation of paſte for the purpoſe of making bread; one of the moſt common is the matter which collects on the ſurface of fermenting liquids from farinaceous matters. This ſubſtance, which is called barm or yeaſt, is equally efficacious in producing fermentation, and is leſs apt to contaminate the bread with any diſagreeable taſte. 2315 Yeaſt. As it is collected on the ſurface of fermenting beer, it was examined by Weſtrumb, and was found to contain a great variety of ingredients. Beſides the water, which was in greateſt proportion, it conſiſted of gluten, ſugar, and mucilage, with a quantity of alcohol, and a ſmall portion of malic, acetic, and carbonic acids. 2316 Component parts. The eſſential parts of barm or yeaſt were found, by the ſame chemiſt, to be gluten mixed with a vegetable acid; and therefore yeaſt, which has been collected and put into bags ſtrongly preſſed and dried, by which means it is obvious many of the component parts muſt be ſeparated, has been found equally fit for fermentation.

2317 Baking of bread. 2. When the paſte has undergone the proper degree of fermentation, it is formed into loaves, and introduced into an oven, which has been previouſly heated. The ſame temperature is as nearly as poſſible employed for the baking of bread. This is regulated by throwing a little flour on the bottom of the oven. If it becomes black, without taking fire, the oven is ſuppoſed to have acquired a proper temperature. This is found to be about 448°.

2318 Changes. 3. If the fermentation has been properly conducted, the bread during the proceſs of baking enlarges in bulk, becomes light and porous, and is full of eyes or cavities, in conſequence of the extrication of the gas which was confined by the viſcid, glutinous matter, and now driven off by means of heat. It is alſo conſiderably lighter, in conſequence of the evaporation of moiſture; and it ſtill continues to loſe weight by being kept, if it be expoſed to the air. When it is firſt removed from the oven, bread is diſtinguiſhed by a peculiar taſte and odour. Theſe are alſo carried off by the evaporation of the moiſture, unleſs it be prevented by excluding the air. The component parts of bread, ſo far as they have been inveſtigated, are quite different from thoſe of the flour, ſo that theſe have undergone a chemical change.

2319 Bread of rye and potatoes. 4. Loaf bread is uſually made of wheat flour, which is found moſt proper for this purpoſe, in conſequence of the great proportion of gluten which it contains. Rye is alſo frequently employed in making bread, but being deficient in the proportion of gluten, it is leſs proper for the purpoſe. Bread made of rye has not the lightneſs and porouſneſs of the wheaten loaf. Parmentier has deſcribed a proceſs for making bread from potatoes. The potatoes are boiled and reduced to a fine paſte; but before they can be converted into bread, it is neceſſary to add an equal weight of ſtarch obtained from the ſame root. In this way a white, well-raiſed bread, it is ſaid, is obtained.

2320 Colouring fermentation. To a fermentation ſomewhat ſimilar is aſcribed the production of the colouring matter of ſome vegetable ſubſtances, as for inſtance that of indigo; in this, however, greater changes are effected. In this proceſs the indigo plants are put into water, which is ſoon agitated with an inteſtine motion. It is alſo accompanied with an increaſe of temperature, the production of a frothy matter on the ſurface, and the evolution of an elaſtic fluid, which is a mixture of carbonic acid and carbonated hydrogen gas. During this proceſs, the colouring matter of the plant is ſeparated and precipitated, from which Fourcroy propoſes to denominate this the *colouring* fermentation.

IV. Of the Putrid Fermentation of Vegetables.

2321 Nature. 1. The putrefactive proceſs is the laſt ſtage in the decompoſition of vegetable matters. In ſome the parts are completely ſeparated, and reſolved into their primary elements by the eſcape of thoſe ſubſtances by which they were mutually held together. In others, new compounds are formed, by a new ſet of attractions and combinations.

2322 Conditions. 2. Several conditions are neceſſary to promote putrefaction. The firſt requiſite is water, without which the proceſs does not go on. When vegetables are kept perfectly dry, they undergo no change. The contact of air is alſo neceſſary, [and a moderate temperature. When the temperature is too high, the moiſture is carried off by evaporation, before the changes in which this proceſs conſiſts can be effected; but when the moiſture is not carried off, the higher the temperature, the more rapid is the putrefaction.

2323 Phenomena. 3. When vegetables are placed in proper circumſtances to favour this proceſs, the colour and conſiſtence are ſoon changed; the texture is deſtroyed, the fibres are ſeparated; the ſoft and liquid parts ſwell up and are covered with froth; elaſtic fluids are diſengaged, the temperature is increaſed, and ſometimes ſo high as to produce actual inflammation. The gaſes which are diſengaged, are, after the proceſs has fairly commenced, accompanied with a fetid odour. They are compoſed of a mixture of carbonated hydrogen, carbonic acid, and azotic gaſes. After theſe phenomena have continued for ſome time, which is longer or ſhorter, according to the nature and conſiſtence of the vegetable matters, great part, it appears, has been diſſipated by evaporation. There remains a dark coloured ſubſtance containing the more fixed materials of the vegetable, as the earths combined with the acids and part of the carbone.

2324 Changes. 4. In obſerving the neceſſary conditions, the phenomena, and the products of the putrid fermentation of vegetables, the influence of the numerous attractions of the different materials which enter into their compoſition is manifeſt. Part of the hydrogen combines with the oxygen, and is carried off in the ſtate of water, part eſcapes in the ſtate of gas combined with a portion of carbone, and another portion of hydrogen unites with the azote of thoſe plants which contain it, and forms ammonia. A fourth part remains behind, and communicates odour and colour to the reſiduary maſs. The carbone combines partly with the diſengaged hydrogen, partly with the oxygen, forming carbonic acid, and part remains behind. The oxygen is divided between the hydrogen and carbone, forming compounds of which theſe elements are the baſe.

SECT. III. *Of the* COMPONENT *Parts of* VEGETABLES.

2325 Obtained by different proceſſes. 1. Having in the two former ſections given a ſhort view of the functions and ſpontaneous decompoſition of plants, we are now to conſider the nature and properties of thoſe ſubſtances which enter into their compoſition. Some of theſe ſubſtances are obtained from plants, while they continue to exhibit the phenomena of vegetation; ſuch are ſaccharine matters obtained from the ſap, which is extracted by wounding the bark and wood, without much ſeeming injury to the health and growth of the plant; and ſuch too are gummy and reſinous matters, which many plants throw off by ſpontaneous exudation; and which, ſo far from being injurious, is perhaps neceſſary in ſome degree to vegetation; but, in general, the ſubſtances formed during the proceſs of vegetation, or which are conſtituent parts of vegetable matters, can only be obtained by the deſtruction of the vegetable itſelf. Theſe are procured by different proceſſes, which we ſhall ſhortly deſcribe, in treating of the nature and properties of each individual ſubſtance.

2326 Enumeration of ſubſtances. 2. The component parts of vegetables, ſo far as they have been examined, and ſufficiently characterized by diſtinct properties, may be enumerated under the following heads:

1. Gum,
2. Sugar,
3. Jelly,
4. Acids,
5. Starch,
6. Albumen,
7. Gluten,
8. Extractive matter,
9. Colouring ditto,
10. Bitter ditto,
11. Narcotic ditto,

12. Oils,
13. Wax,
14. Camphor,
15. Caoutchouc,
16. Reſins,
17. Gum-reſins,
18. Wood,
19. Tan,
20. Suber,
21. Alkalies,
22. Earths,
23. Metals.

I. Of Gum.

2327 Extraction and properties. 1. Gum exudes from many trees during the proceſs of vegetation, in the form of a viſcid, tranſparent, inſipid fluid. The finer kind of gum is obtained chiefly from the *mimoſa nilotica*, a plant which is very common in many parts of Africa. This gum is uſually diſtinguiſhed by the name of *gum arabic*. After it ſeparates from the tree, the watery part evaporates, and the gum remains behind. It has then ſome degree of hardneſs, and is ſo brittle that it may be reduced to fine powder. It retains its tranſparency, is generally of a yellow colour; but, when pure, it is entirely colourleſs. It has neither taſte nor ſmell. The ſpecific gravity is from 1.316 to 1.481.

2328 Action of air and heat. 2. Gum is not changed by expoſure to the air, but it is deprived of its colour by the action of the ſun's light. When it is expoſed to heat, it becomes ſoft, ſwells up, gives out air-bubbles, blackens, and is reduced to charcoal. During this change it gives out very little flame, and is greatly enlarged in volume. It readily diſſolves in water. The ſolution is thick and adheſive, and well known as a paſte, under the name of *mucilage*. This ſolution is little diſpoſed to decompoſition. By evaporation the whole of the gum may be obtained unchanged.

2329 Of acids. 3. Gum is ſoluble in the vegetable acids without decompoſition. Sulphuric acid decompoſes it, and converts it into water, acetic acid, and charcoal. With the aſſiſtance of heat, muriatic acid produces a ſimilar effect. Oxymuriatic acid converts it into citric acid.

Gum is ſoluble in nitric acid with the aſſiſtance of heat. Nitrous gas is emitted during the ſolution, and, when it cools, ſaclactic acid is depoſited. Malic acid appears at the ſame time; and by continuing the heat, the gum is at laſt converted into oxalic acid. Four hundred and eighty grains of gum digeſted with ſix ounces of nitric acid, afforded Mr Cruickſhank 210 grains of oxalic acid, and ſix grains of oxalate of lime.

2330 Alcohol. 4. By pouring alcohol into a mucilaginous ſolution, the gum is precipitated, ſo that it is inſoluble in this liquid. It is alſo inſoluble in ether.

2331 Diſtillation. 5. Mr Cruickſhank diſtilled 480 grains of gum arabic by expoſing it to a red heat in a glaſs retort, and obtained the following products:

Acetic acid mixed with ſome oil	210	grs.
Carbonated hydrogen and carbonic acid gaſes	164	
Charcoal	96	
Lime and a little phoſphate of lime	20	
	480	

2332 Conſtituents. Thus the conſtituent parts of gum are, oxygen, hydrogen, carbone, azote, and lime.

2333 Obtained from other plants. 6. Beſides gum arabic, the properties of which we have now deſcribed, there are different ſpecies of gum obtained from different plants, which, however, in their general properties reſemble gum arabic. In ſome indeed they ſeem to be different, but theſe differences have not been diſtinctly aſcertained. Gum tragacanth, the produce of the *aſtragalus tragacantha*, which is in the form of vermicular maſſes, is leſs tranſparent than gum arabic, leſs ſoluble in water, and more adheſive; but yields by diſtillation ſimilar products. Gum obtained from the cherry and plum tree, is of a browniſh colour, ſofter and more ſoluble in water, but ſeems otherwiſe to poſſeſs nearly the ſame properties as gum arabic.

2334 Mucilage exiſts in many plants. 7. Gum in the ſtate of mucilage exiſts in a great number of plants, and eſpecially in the roots and leaves. It ſeems to be moſt abundant in bulbous roots, as thoſe of the hyacinth, which contain ſuch a quantity that they may be advantageouſly employed in place of gum arabic. It is obtained alſo in conſiderable quantity from many of the lichens, and moſt of the fuci. Mucilage is found in greateſt proportion in young plants, but this proportion diminiſhes with the age of the plant. It is a principal conſtituent in the leaves and roots of eſculent vegetables.

2335 Uſes. 8. In the ſtate of mucilage, gum conſtitutes a nutritious aliment. On account of its adheſive properties, it is employed as a paſte, and by the calico-printers to mix with their colours to give them conſiſtency. It is well known as a component part of ink, to prevent the precipitation of its more inſoluble ingredients, and it forms a very valuable article in the Materia Medica.

II. Of Sugar.

2336 In all parts of plants. 1. Sugar exiſts in every part of plants. It is found in the roots, as thoſe of the carrot and beet root; in the ſtems, as in the birch, the maple, ſome palms, and eſpecially the ſugar-cane; in the leaves, as thoſe of the aſh; in the flowers, the fruits, and ſeeds.

2337 Sugar-cane. 2. But the ſugar which now forms a very extenſive article of commerce, and may be conſidered as a neceſſary of life, is entirely obtained from the juice of the ſugar-cane, which is chiefly cultivated in the Eaſt and Weſt Indies, for the purpoſe of extracting the ſugar. When the plants have arrived at their
2338 Manufacture. full growth, which in the Weſt Indies is in the courſe of 12 or 14 months, they are cut down and bruiſed by means of machinery; the juice which is collected, is conveyed to iron boilers, where it is boiled, with the addition of a ſmall quantity of quicklime, and the impurities which riſe to the ſurface are ſcummed off. The boiling is continued till it acquires the conſiſtence of ſyrup, after which it is put into ſhallow veſſels, where it is allowed to cool and granulate. In general, it is afterwards put into hogſheads, in which it is imported to Europe, the bottoms of which are perforated, that the molaſſes with which the ſugar is mixed, may be allowed to drain off. Sometimes it is put into conical earthen veſſels, open at both ends, the baſe of which is covered with moiſt clay, ſo that the water filters through the ſugar, and carries with it a greater quantity of the molaſſes and other impurities. The ſu-

gar thus treated, is called clayed ſugar. It is not different from the former, but in being ſomewhat purer. The addition of quicklime in the boiling is ſuppoſed to take up ſome vegetable acids which prevent the granulation of the ſugar.

2339 Raw. 3. In this ſtate the ſugar is known in commerce by the name of *raw Muſcovado ſugar*. It is ſtill farther purified by diſſolving it in water, and boiling, when the impurities which riſe to the ſurface are again removed; a quantity of lime is alſo added, and it is clarified with blood. When boiled down to a proper conſiſtency, it is put into unglazed earthen veſſels of a conical ſhape, and inverted, to allow the water from the moiſt clay with which the baſe of the cone is covered, to paſs through the ſugar, and carry off its impurities. It is ſtill farther purified by again diſſolving it in water, and ſubjecting it to a ſimilar proceſs. According to the number of proceſſes to which it has been ſubjected, it is called ſingle or double refined ſugar.

2340 Properties. 4. Sugar in this ſtate is of a white colour; it is well known for its ſweet taſte; it has no ſmell. It has ſome degree of tranſparency when it is cryſtallized. It is conſiderably hard; but it is brittle, and may be eaſily reduced to powder. It is phoſphoreſcent in the dark. When the ſolution of ſugar in water is concentrated, it cryſtallizes in the form of ſix-ſided priſms, terminated by two-ſided ſummits. The ſpecific gravity of ſugar is 1.4045.

2341 Action of heat. 5. When ſugar is expoſed to heat, it melts, ſwells up, becomes of a dark brown or black colour, emits air bubbles with a peculiar ſmell, which has been called *caromel*. If a red heat he applied, it ſuddenly burſts into flames, with a kind of exploſion.

2342 Water. 6. Neither oxygen nor azote have any action on ſugar. It is not altered by expoſure to the air. If the air be moiſt, it abſorbs a little water. There is no action between hydrogen and ſugar. It is very ſoluble in water; at ſo low a temperature as 48°, water diſſolves its own weight of ſugar. This power increaſes with the temperature of the water. When water is ſaturated with ſugar, it is called ſyrup, which by concentration and reſt affords cryſtals.

2343 Acids. 7. Sugar is ſoluble in many of the acids. It is decompoſed by ſulphuric acid; when heat is applied, the acid itſelf is decompoſed, and converted into ſulphurous acid; and a great quantity of charcoal is depoſited.

Nitric acid acts on ſugar with conſiderable violence; an efferveſcence is produced, nitrous gas is emitted; and the ſugar is converted into oxalic and malic acids.

Muriatic acid gas is ſlowly abſorbed by ſugar, which becomes of a brown colour, and acquires a very ſtrong ſmell. Sugar is inſtantly diſſolved when it is thrown in the ſtate of powder into liquid oxymuriatic acid; it is converted into malic acid, while the oxymuriatic acid is deprived of its oxygen, and reduced to the ſtate of muriatic acid. Alcohol readily diſſolves ſugar. One part of ſugar is ſoluble in four of boiling alcohol. Sugar alſo combines with the oils, and by this means they may be mixed with water.

2344 Alkalies. 8. The fixed alkalies combine with ſugar, and deprive it of its ſweet taſte; but by adding ſulphuric acid, and precipitating the ſulphate which is formed by means of alcohol, the taſte is reſtored. Some of the earths, as lime, combine with ſugar, and form ſimilar compounds.

2345 Sulphurets, &c. 9. The ſulphurets, hydroſulphurets, and phoſphurets of the alkalies and ſome of the earths, decompoſe ſugar, and reduce it to a ſtate ſomewhat ſimilar to gum. Mr Cruickſhank diſſolved a quantity of ſugar in alcohol, and added to it phoſphuret of lime. After expoſing the mixture to the open air for ſome days, it was evaporated, and water was added. There was no evolution of gas, and the phoſphuret was found converted into a phoſphate. By filtering the liquid, and by evaporation, a tenacious ſubſtance, reſembling gum, remained behind.

10. By diſtilling ſugar in a retort, the firſt part of the product is water, nearly in a ſtate of purity. Acetic acid with a little oil next comes over, and afterward empyreumatic oil. A bulky carbonaceous matter, which ſometimes contains a little lime, remains behind. Mr Cruickſhank obtained by the diſtillation of 480 grains of pure ſugar, by means of a red-heat,

Acetic acid and oil, - -	270 grs.
Charcoal, - - -	120
Carbonated hydrogen and carbonic acid gaſes	90
	480

2346 Conſtituent parts. Sugar, therefore, is compoſed of oxygen, carbone, and hydrogen. The proportions of its conſtituent parts, according to Lavoiſier, are the following:

Oxygen,	64
Carbone,	28
Hydrogen,	8
	100

2347 Maple ſugar. 11. Sugar is alſo obtained from the juice of the maple tree in North America. The juice is extracted from the tree during the aſcent of the ſap in the ſpring ſeaſon. A ſingle tree, it is ſaid, yields from 20 to 30 gallons of ſap, from which are obtained five or ſix libs. of ſugar. It is manufactured in the ſame way as the juice of the ſugar-cane.

2348 Beet root. It has lately been propoſed to extract ſugar from the root of the beet; and the attempt has been made, even in the large way, by Achard of Berlin. The proceſs which he followed is to boil the roots, cut them into ſlices, and extract the juice by preſſure. The roots are again put into water for 12 hours, and again ſubjected to the preſs. The liquids thus obtained are filtered through flannel, boiled down to $\frac{2}{3}$, and filtered a ſecond time. The remaining liquid is reduced by boiling to $\frac{1}{3}$ of the original quantity, and again filtered. It is then evaporated to the conſiſtence of ſyrup. The cruſt which forms on the ſurface muſt be broken from time to time, and the ſpontaneous evaporation allowed to continue till the ſurface is covered with a viſcid pellicle, inſtead of the cryſtals which firſt form on it. The whole maſs is then introduced into woollen bags, and the mucilage is ſeparated by preſſure. This ſugar, which in many reſpects poſſeſſes the properties of common ſugar, is contaminated with ſome matter, which communicates a bitter nauſeous taſte. Many other plants alſo contain ſugar, either in the roots, the ſap, or the ſeeds. It exiſts in wheat, barley, beans, peaſe, and other leguminous ſeeds, eſpecially when they are young, in conſiderable quantity.

2349 Uſes. 12. The uſes of ſugar are ſo familiar, that it is ſcarcely neceſſary to enumerate them. In moſt countries where it can be obtained, it may be conſidered in ſome meaſure as a neceſſary of life. It contains a great proportion of nutritious matter. It is not changed by the action of the air, ſo that it may be preſerved for any length of time. It is employed to preſerve other vegetable matters from putrefaction, and ſometimes it is alſo advantageouſly applied to a ſimilar purpoſe, in the preſervation of animal ſubſtances.

III. Of Jelly.

2350 Preparation. 1. Jelly is a ſoft tremulous ſubſtance which is obtained from the juice of different fruits, eſpecially from currants and bramble berries. The juice is extracted by expreſſion, and when it is allowed to remain at reſt, it coagulates. It is ſtill mixed with a portion of aqueous liquid; but this being poured off, and the coagulated part waſhed with water, the jelly remains nearly pure.

2351 Properties. 2. It is ſometimes perfectly colourleſs, but frequently tinged with the colouring matter of the fruit. It is of a ſoft, tremulous conſiſtence, and has an agreeable, ſlightly acid taſte. It diſſolves readily in hot water, and again coagulates on cooling. In cold water it is nearly inſoluble. It is deprived of the property of coagulating by boiling, and then it is ſimilar to mucilaginous matter.

2352 Reſembles gum. 3. By coagulating the juices of the fruits which yield jelly, ſeparating the liquid parts by filtration, afterwards waſhing the coagulum with cold water, and by allowing the maſs to dry, it is found diminiſhed in bulk, and is tranſparent and brittle, having many of the properties of gum; ſo that it has been ſuppoſed that jelly is this latter ſubſtance in combination with ſome vegetable acid.

2353 Action of nitric acid. 4. Jelly is converted into oxalic acid by means of nitric acid. It combines readily with the alkalies; and when it is diſtilled, it yields a conſiderable portion of acetic acid mixed with oil, but no perceptible quantity of ammonia. Jelly is found in all the acid fruits, as in gooſeberries, oranges, and lemons.

IV. Of Acids.

2354 Eaſily known. 1. The acids which exiſt in many vegetables are at once recognized by their taſte. Theſe acids were formerly denominated *eſſential ſalts of vegetables*, and it was ſuppoſed, that all eſſential ſalts were the ſame, and were compoſed of tartar, or vinegar. But Scheele's diſcovery of the citric, malic, and gallic acids, which poſſeſſing diſtinct properties from thoſe of tartaric and acetic acids, proved the contrary. Some vegetables contain only one acid, as oranges and lemons, which contain citric acid only. In other vegetables two acids are found, as in gooſeberries and currants, the malic, and citric acids; and ſometimes three, as the tartaric, citric, and malic acids, which exiſt together in the pulp of the tamarind. As the acids which exiſt in vegetables have been already deſcribed, with the method of preparing them, it is now only neceſſary to enumerate the vegetable acids, ſpecifying at the ſame time ſome of the plants from which they are obtained.

2355 Acetic. 2. Acetic acid has been diſcovered in the ſap of ſome trees, and in the acid juice of *cicer arietinum*. In the latter it is mixed with oxalic and malic acids. Acetic acid was detected by Scheele in the *ſambucus nigra* or elder.

2356 Oxalic. 3. Oxalic acid exiſts in combination with potaſh, in the leaves of the *oxalis acetoſella* or wood-ſorrel. In other ſpecies belonging to the ſame genus, and in ſome ſpecies of rumex, it is in the ſtate of acidulous oxalate of potaſh. Oxalate of lime has been found in the root of rhubarb.

2357 Tartaric. 4. The following vegetable ſubſtances contain tartaric acid; in which, however, it is combined with potaſh, in the ſtate of acidulous tartrate of potaſh. In this ſtate it is found in the pulp of the tamarind, the juice of grapes, of mulberries, of *rumex acetoſa* or ſorrel, of *rheum raponticum*, or rhubarb, and of *agave americana*. It is found alſo in the roots of *triticum repens*, or couch-graſs, and in *leontodon taraxacum*, or dandelion.

2358 Citric. 5. Citric acid is found in the juice of oranges and lemons, in the berries of two ſpecies of *vaccinium*, the *oxycoccos* or cranberry, and the *vitis idæa* or red whortleberry, the *prunus padus*, or bird-cherry, *ſolanum dulcamara*, bitter-ſweet, or nightſhade, *roſa canina*, or wild roſe.

2359 Malic. 6. Malic acid exiſts unmixed with other acids, in the apple, the barberry, plum, ſloe, elder, rowan, or fruit of the mountain aſh.

In the gooſeberry, in the cherry, ſtrawberry, currants and ſome other fruits, malic and citric acids are found nearly in equal proportions.

Malic acid has been found mixed with tartaric acid in the *agave americana*, and in the pulp of tamarinds, along with citric acid. Vauquelin found it combined with lime, forming a malate of lime, in the *ſempervivum tectorum* or houſe-leek; in three ſpecies of *ſedum* or ſtone-crop, namely the *album*, *acre*, and *telephium*; in different ſpecies of *craſſula* and *meſembryanthemum*, and in *arum maculatum*.

2360 Gallic. 7. Gallic acid is found in a great number of plants, and in them it exiſts chiefly in the bark. The following are the relative proportions of the quantity of gallic acid in different plants, as they have been aſcertained by Mr Biggin.

Elm	7	Sallow	8
Oak cut in winter	8	Mountain aſh	8
Horſe-cheſnut	6	Poplar	8
Beech	7	Hazel	9
Willow boughs	8	Aſh	10
Elder	4	Spaniſh cheſnut	10
Plum-tree	8	Smooth oak	10
Willow trunk	9	Oak cut in ſpring	10
Sycamore	6	Huntingdon or Leiceſter willow	10
Birch	4		
Cherry-tree	8	Sumac	14[*]

2361 Benzoic. 8. Benzoic acid is found in benzoin, balſam of Tolu and Peru, liquid ſtyrax, cinnamon, and vanilla. Fourcroy and Vauquelin ſuſpect that it exiſts in the *anthoxanthum odoratum*, or ſweet-ſcented graſs, which communicates the aromatic flavour to hay.

[*] *Nichol. Jour.* iii. p. 394. 4to.

2362 Pruſſic. 9. Pruſſic acid has been found in the leaves of the lauroceraſus and peach, in bitter almonds, in the kernels of apricots; and it is ſuppoſed that it exiſts alſo in the kernels of peaches, of plums, and cherries. It is obtained from the kernels of apricots by diſtilling water off them with a moderate heat; and if lime be added to the concentrated infuſion of bitter almonds, a pruſſiate of lime is formed.

2363 Phoſphoric. 10. Phoſphoric acid has been found in different parts of plants; but it is generally combined with lime, forming a phoſphate of lime. This ſalt exiſts in the leaves of many trees, in the *aconitum napellus*, or monks-hood, and in all kinds of grain.

V. Of Starch.

2364 Preparation. 1. If a paſte be formed of wheat flour and water, and this be waſhed with additional quantities of water, till it is no longer turbid, but comes off pure and colourleſs, the maſs which remains becomes tenacious and ductile. This is called *gluten*, which will be afterwards deſcribed. If the water with which the paſte was waſhed be allowed to remain at reſt, it depoſits a white powder, which is diſtinguiſhed by the name of *fecula* or *ſtarch*.

2365 Properties. 2. Starch is of a fine white colour, and is uſually in the ſtate of concrete columnar maſſes. It has no perceptible ſmell, and ſcarcely any taſte. It is little altered by expoſure to the air; 2366 Action of heat. when it is expoſed to heat on a hot iron, it melts, ſwells up, becomes black, and burns with a bright flame. The charcoal which remains, contains a little potaſh. When it is diſtilled, it gives out water mixed with acetic acid, which is contaminated with oil. It gives out alſo carbonic acid and carbonated hydrogen gas.

3. Starch is not ſoluble in cold, but forms a thick paſte with boiling water, and when this paſte is allowed to cool, it becomes ſemitranſparent and gelatinous; it is brittle when dry, ſomewhat reſembling gum. If this paſte be expoſed to moiſt air, it is decompoſed, for it acquires an acid taſte.

2367 Of acids. 4. Sulphuric acid diſſolves ſtarch ſlowly; ſulphurous acid is diſengaged, and a great quantity of charcoal is formed.

Muriatic acid alſo diſſolves ſtarch, and the ſolution reſembles mucilage of gum arabic. When left at reſt, a thick, oily, mucilaginous liquid appears above, and a tranſparent ſtraw-coloured fluid below. The odour of muriatic acid remains; but when water is added, it is deſtroyed, and a ſtrong peculiar ſmell is emitted.

Starch is alſo ſoluble in nitric acid, with the evolution of nitrous gas. The ſolution aſſumes a green colour, and when heat is applied, the ſtarch is converted into oxalic and malic acids. Some part of the ſtarch, however, is inſoluble in nitric acid, and when this is ſeparated by filtration, and waſhed with water, it has a thick oily appearance like tallow, is ſoluble in alcohol, and when diſtilled, yields acetic acid, and an oily matter ſimilar to tallow in colour and conſiſtence.

2368 Compoſition. 5. Starch is inſoluble in alcohol, but is ſoluble in the alkalies; in pure potaſh it ſwells up, becomes tranſparent and gelatinous, and is then ſuſceptible of ſolution in alcohol. The component parts of ſtarch, as appears by diſtilling it, and by the action of reagents, are oxygen, hydrogen, and carbone.

6. Starch exiſts in a great number of vegetable ſubſtances, but chiefly in the roots and ſeeds, and particularly thoſe which are employed as food. 2369 Found in roots and ſeeds.

2370 Potato. Starch, it is well known, may be obtained from the potato. If the potato be grated down and waſhed with water till it comes off pure and colourleſs, this water being left at reſt, depoſits a fine white powder, which aſſumes ſomething of a cryſtallized appearance, and is heavier than wheat ſtarch.

2371 Sago. Sago, which is well known on account of its nutritious qualities, is obtained from the pith of different ſpecies of palms, which grow within the topics. The ſtem is cut into pieces, which are ſplit into two; the pith is waſhed out with cold water, which being left at reſt, depoſits the ſtarch. The water is poured off, and before the remaining maſs is fully dried, it is forced through a perforated veſſel, and granulated, in which ſtate it is brought to Europe.

2372 Saloup. Saloup, which is chiefly compoſed of ſtarch, is prepared from the roots of different ſpecies of orchis. It is moſtly imported from Perſia.

2373 Caſſava. Caſſava, or caſſada, is a kind of bread chiefly compoſed of ſtarch, which is much uſed as an article of food in the Weſt Indies. It is prepared from the roots of the *jatropha manihot*. The roots are well waſhed, grated down, and put into bags, which are ſubjected to ſtrong preſſure. By this proceſs the whole of the juice is ſeparated. This juice, or ſomething at leaſt which it holds in ſolution, when taken internally, is a deadly poiſon to moſt animals. The matter remaining in the bag is dried and ſifted, and without any other addition, when it is ſpread thin on a hot ſtone, it forms a cake, which is the caſſada bread, found to be of a very nutritious quality, in conſequence of the great proportion of ſtarch which it contains.

1374 Lichen. Some ſpecies of the tribe of lichen contain a conſiderable proportion of ſtarch, as the lichen rangiferinus, or rein-deer lichen, which affords food to the rein-deer, and the lichen iſlandicus which is formed into bread by the Icelanders, and is found to be extremely nutritious. The latter has lately been recommended as a remedy in conſumption; but it probably poſſeſſes no other virtue in the cure of that fatal diſeaſe, than affording a great proportion of nutritious matter in ſmall bulk.

VI. Of Albumen.

1. The exiſtence of albumen in vegetable ſubſtances had begun to be doubted by chemiſts, till it was lately diſcovered, by Vauquelin, in the juice of the *carica papaya*, or *papaw-tree*, which grows in different countries within the torrid zone. The juice which exudes from this tree, was brought home in the liquid ſtate, mixed with an equal quantity of rum, and another portion of the juice was in the ſtate of extract. The firſt was of a reddiſh brown colour, was ſemitranſparent, and had the odour and taſte of boiled beef. The ſecond was of a yellowiſh white colour, ſemitranſparent, and of a ſweetiſh taſte; had no perceptible ſmell, but was of a firm conſiſtence, and in the form of ſmall irregular maſſes. When the dried portion was macerated in cold water, it was almoſt entirely diſſolved. When nitric acid was added, a copious white precipitate was formed. This was the albumen in the

ſtate of white flakes. When the extract of this juice was ſubjected to diſtillation, it yielded carbonate of ammonia, a thick fetid, reddiſh coloured oil, carbonic acid, and carbonated hydrogen gaſes, and there remained behind a light carbonaceous matter; which, being burnt, left a quantity of white aſhes, conſiſting almoſt entirely of phoſphate of lime.

2375 Reſembles animal albumen. 2. From other experiments to which this matter was ſubjected by the ſame chemiſt, from its ſolution in water, its coagulation by means of heat, its action with the acids, the alkalies, metallic ſolutions, the infuſion of nut-galls, and alcohol, he concludes, that it is preciſely of the ſame nature with animal albumen *.

VII. Of Gluten.

2376 Preparation. 1. When a paſte is formed with flour and water, and waſhed with more water till it paſſes off pure and colourleſs, a tenacious, ductile, ſoft, elaſtic maſs remains behind, which is gluten.

2377 Properties. 2. This ſubſtance is of a gray colour, extremely ductile and tenacious, and poſſeſſes conſiderable elaſticity. It has a peculiar ſmell, but no perceptible taſte. When it is ſuddenly dried, it increaſes much in volume, and when it is expoſed to heat, it cracks, ſwells, blackens, and burns like horn, exhaling a fetid odour. When it is diſtilled, it yields water impregnated with ammonia, and an empyreumatic oil; charcoal remains behind. When moiſt gluten is expoſed to the air, it gradually dries, becomes hard, brittle, ſlightly tranſparent, and of a browniſh colour, having ſome reſemblance to glue. When it is broken, it reſembles the fracture of glaſs. It is inſoluble in water, but retains a portion of it, which it abſorbs, and to which the elaſticity and tenacity are owing. It is deprived of theſe properties by boiling.

2378 Ferments. 3. When it is kept moiſt, it ferments with the evolution of hydrogen and carbonic acid gaſes. An offenſive putrid odour is given out at the ſame time. The gluten afterwards, if the proceſs be allowed to go on, exhales the ſmell, and acquires the taſte of cheeſe. In this ſtate it is found to contain ammonia and acetic acid.

2379 Action of acids. 4. Gluten is ſoluble in all the acids. It is precipitated from this ſolution by all the alkalies, and is then nearly in the ſtate of extractive matter, being deprived of its elaſticity. It is decompoſed by concentrated ſulphuric acid; hydrogen gas is emitted, and water, charcoal, and ammonia are formed. It is alſo decompoſed by nitric acid; azotic gas is emitted, and if the heat be continued, a portion of oxalic acid is formed. Yellow coloured oily flakes are precipitated. After gluten is fermented, it is ſoluble in acetic acid, and this ſolution may be employed as a varniſh.

2380 Of alcohol on fermented gluten. 5. Gluten is inſoluble in alcohol and in ether; but if fermented gluten be triturated with a little alcohol, and afterwards mixed with a quantity of the ſame liquid, part of it is diſſolved and forms a varniſh, which may be employed either for paper or wood, for cementing china, or for mixing with vegetable colours that are uſed as paints. Pieces of linen dipped in this varniſh, adhere ſtrongly to other bodies, and if lime be added to the ſolution, it conſtitutes a good lute.

2381 Of alkalies. 6. With the aſſiſtance of heat gluten is ſoluble in the alkalies; and when they are much concentrated, it is decompoſed, and formed into a kind of ſoap, conſiſting of oil and ammonia.

2382 Compoſition. 7. It appears from the diſtillation of gluten, and from its ſpontaneous decompoſition, that it conſiſts of oxygen, hydrogen, carbone, and azote. The vapour which is evolved during the fermentation of gluten, blackens ſilver, from which it is inferred that ſulphur is one of its conſtituent parts. From the properties and compoſition of gluten, the reſemblance between this ſubſtance and animal matter is ſufficiently obvious.

2383 In wheat. 8. Gluten exiſts in greateſt abundance in wheat flour, but it is found in a great number of plants, and in different parts of vegetables. It exiſts in conſiderable proportion in the juice of the leaves of many plants, as thoſe of the cabbage, creſſes, &c. 2384 Leaves. When this juice is procured by expreſſion, filtered through a cloth, and allowed to remain at reſt, it depoſits in the courſe of ſome days, a greeniſh powder, which has been called the green fecula of plants. This fecula is chiefly compoſed of gluten mixed with a reſinous matter, which gives it its colour, and a portion of woody fibre. If this juice be expoſed to the temperature of about 130°, the fecula coagulates in the form of large flakes. It dries when ſeparated from the water, and aſſumes the appearance of horn. When it is treated like gluten, it alſo acquires the ſmell and taſte of cheeſe.

2385 In ſeeds and fruits. Gluten has been found in acorns, cheſnuts, and horſe-cheſnuts, in barley, rye, peaſe, and beans; in apples and quinces; in the leaves of *ſedum* of different ſpecies, hemlock, borrage, ſaffron; in the petals of the roſe, in the berries of the elder, and in the grape. None was detected in the potato by Prouſt, although he found it in ſeveral other roots.

A ſubſtance which reſembles the fibrina of the blood, was found by Vauquelin in the juice of the papaw-tree. When this juice is mixed with water, part is diſſolved, and part remains inſoluble. The latter has a greaſy appearance, becomes ſoft in the air, viſcid, brown, and ſemitranſparent. It melted when thrown on burning coals, while drops of greaſe exuded. It was entirely conſumed, without leaving any reſiduum. But according to ſome, this ſubſtance is exactly ſimilar to gluten, and therefore, is not to be conſidered as one of the conſtituents of vegetable matter.

2386 Uſes. 9. Gluten is one of the moſt important of the component parts of vegetable ſubſtances. It is one of the chief ingredients in wheat, and to this it is owing that wheat flour is fit for being formed into bread.

VIII. Of Extractive Matter.

2387 Preparation. 1. The word *extract* was formerly employed to ſignify the inſpiſſated juices of vegetables, but of late it has been limited to a peculiar principle poſſeſſed of diſtinct properties. If ſaffron be infuſed in water for ſome time, and if the infuſion be filtered and evaporated to dryneſs, the reſiduum is that ſubſtance to which the name of extractive principle is given.

2388 Properties. 2. The following properties of extract were aſcertained by Vauquelin. 1. All extracts have an acid taſte. 2. If a few drops of ammonia be added to a ſolution of extract, a brown precipitate is formed, which conſiſts of lime, and part of the extract becomes inſoluble. 3. Sulphuric acid diſengages a penetrating acid vapour, which is found to be acetic acid. 4. When quicklime is added to a ſolution of extractive matter, ammonia is diſengaged. A ſolution of ſulphate of alumina without exceſs of acid, being poured into a ſolution of extractive matter, and boiled, there is formed in the liquid a flaky precipitate which is compoſed of alumina and vegetable matter, and rendered inſoluble in water. 6. Almoſt all metallic ſolutions produce a ſimilar effect. With muriate of tin an inſoluble brown precipitate is formed, which is compoſed of the oxide of tin and vegetable matter. 7. Oxymuriatic acid poured into a ſolution of extractive matter, forms a copious, dark yellow precipitate. Muriatic acid remains in the ſolution. 8. If wool, cotton, or thread, be impregnated with alum, and boiled with a ſolution of extractive matter, theſe ſubſtances become charged with a great quantity of the extractive ſubſtance, they aſſume a fawn-brown tint, and the ſolution loſes a great deal of its colour. The ſame effect is produced by immerſing the ſubſtances to be dyed in a ſolution of muriate of tin. The effect is ſtill better, if oxymuriatic acid be employed inſtead of alum, or the ſolution of muriate of tin. 9. When extractive matter is diſtilled in an open fire, it yields an acid liquid, which contains a greater portion of ammonia than when it is diſtilled in the humid way with lime or alkali. 10. When extractive matter is diſſolved in water, and is left expoſed to the open air, it is completely decompoſed. The carbonates of potaſh, of ammonia, and of lime, and ſome other mineral ſalts which previouſly exiſted in the extractive matter, and are indeſtructible by putrid fermentation, remain behind.

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* *Ann. de Chim.* xliii. p. 270. and xlix. p. 304.

2389 Exiſts in old plants.

3. It appears that extractive matter is found in greater proportion in old plants. It is found in different parts of the plant. If frequently forms one of the conſtituents of the ſap. It is this extractive matter which precipitates during the evaporation of the ſap, or when oxymuriatic acid is added to it.

2390 In the bark.

Extractive matter has been found in the bark of many trees, and it is ſuppoſed that it exiſts in all barks which poſſeſs an aſtringent property. It has been found in the bark of the common willow, the Leiceſter willow, the oak, and the elm.

2391 Catechu.

Extractive matter has been obtained from the infuſion of catechu, in which it is united with tan. If the powder of catechu be repeatedly waſhed with water, the liquid which paſſes off no longer precipitates gelatine. The reſiduum is extractive matter, of a reddiſh-brown colour, has no ſmell, but a ſlightly aſtringent taſte. The ſolution in water is at firſt yellowiſh-brown, but acquires a red colour by expoſure to the air. Many of the metallic ſalts form a precipitate with the ſolution of this matter. Linen boiled in it almoſt extracts the whole, and becomes of a light red brown colour. Extractive matter ſoftens when expoſed to heat; the colour becomes darker, but it does not melt. When it is diſtilled, it yields carbonic and carbonated hydrogen gaſes, acetic acid, and a ſmall portion of extractive matter unchanged. A light porous charcoal remains behind.

2392 Senna.

The infuſion of the leaves of ſenna is of a brown colour, has a peculiar aromatic odour, and a bitter taſte. When the air of the atmoſphere or oxygen gas is made to paſs through this infuſion, a yellow coloured precipitate is formed. It is produced alſo by adding to the ſolution muriatic or oxymuriatic acid. In this ſtate the extractive matter has combined with oxygen, and has aſſumed a yellow colour, and being no longer ſoluble in water, it is precipitated. The taſte is ſlightly bitter. It is ſoluble in alcohol, but when water is added, it is thrown down. It is ſoluble alſo in alkalies, and forms with them a deep brown ſolution. When placed on burning coals, it gives out a denſe ſmoke, exhales an aromatic odour, and leaves behind a ſpongy maſs of charcoal.

2393 Peruvian bark.

Extractive matter is obtained from the infuſion of Peruvian bark, which being united with oxygen, becomes of a fine red colour. It is obtained by boiling water on it, and by ſlow evaporation, and then diſſolving what remains in alcohol. By evaporating the alcohol, the peculiar extractive matter is depoſited. The matter thus obtained was of a brown colour, of a bitter taſte, ſoluble in hot water and alcohol, but inſoluble in cold water. It is of a black colour when dry, and brittle. It breaks with a poliſhed fracture. With the addition of lime-water it was precipitated in the form of a fine red powder, which combined with alkalies, but is inſoluble in water and alcohol.

IX. Of Colouring Matter.

2394 Exiſts in many plants.

1. Colouring matter is extracted from a number of plants for the purpoſes of dyeing, as from madder, carthamus, brazil wood, logwood, yellow weed or reſeda luteola, fuſtic or yellow-wood, anatto, and indigo.

2395 Madder.

2. The colouring matter of madder or *rubia tinctorum*, is ſoluble in alcohol. By evaporation it leaves a reſiduum of a dark red colour. A violet precipitate is formed in this ſolution by a fixed alkali. Sulphuric acid produces a fawn-coloured precipitate, and ſulphate of potaſh, a beautiful red. Precipitates of different ſhades of colour are obtained with alum, nitre, chalk, acetate of lead, and muriate of tin.

2396 Carthamus.

3. Carthamus (tinctorius) contains two colouring matters, the one yellow and the other red. The firſt only is ſoluble in water, but the ſolution is turbid. It becomes tranſparent with the addition of acids; with alkalies it inclines to an orange colour; a fawn-coloured precipitate is formed, and then the ſolution becomes clear. Alum produces a dark yellow precipitate, but not very copious. A ſlight tincture is extracted from the flowers of this plant by means of alcohol, after the whole of the yellow matter has been diſſolved by water.

2397 Brazil wood.

4. Brazil wood, or *fernambouc*, is much employed in dyeing. A recent decoction of this wood gives a red precipitate inclining to fawn colour with ſulphuric acid. The liquid in which the ſolution was made remains tranſparent and of a yellow colour. With the firſt addition of nitric acid the tincture firſt paſſes to a yellow colour; but with a greater quantity, becomes of a dark orange yellow and tranſparent, after having depoſited a matter ſimilar in colour to the former, but more copious. The ſame changes take place with the muriatic acid as with the ſulphuric.

2398 Logwood.

5. Logwood or *Campeachy wood* yields its colouring matter to water and to alcohol, but more copiouſly to the latter. The tincture of logwood, or the ſolution in alcohol, is of a beautiful red colour, inclining to violet or purple. Theſe different ſhades are more obvious in the decoction in water. When the aqueous ſolution

left to itſelf, it firſt becomes yellow, and then changes to black. The addition of acids produces a yellow colour; alkalies deepen the colour and reſtore the purple or violet. Sulphuric, nitric, and muriatic acids throw down a light precipitate which ſeparates ſlowly. Sulphate of iron communicates a bluiſh colour ſomewhat reſembling ink. A copious precipitate of a ſimilar colour is formed at the ſame time.

2399 Yellow weed. 6. Yellow weed, or dyers weed (*reſeda luteola* Lin.) in ſolution in water yields a yellow colour inclining to brown. When it is diluted with a greater quantity of water, the yellow colour which was more or leſs bright changes a little to green. The colour becomes paler with the addition of acids. It becomes deeper by the action of alkalies.

2400 Fuſtic. 7. Fuſtic, or yellow wood (*morus tinctoria*, Lin.) contains a great proportion of colouring matter. A ſtrong decoction in water is of a dark reddiſh yellow colour. When water is added to this ſolution the colour becomes orange-yellow. The liquid grows turbid with the addition of acids. Alkalies render it much deeper and nearly red.

2401 Anatto. 8. Anatto is in the form of a dry hard paſte, externally brown, and internally of a beautiful red colour. It is prepared from the ſeeds of the *bixa orellana* by reducing them to powder, mixing them with water, and allowing them to ferment. Anatto is more ſoluble in alcohol than in water. With the addition of an alkali the ſolution is promoted, and the colour inclines leſs to red.

Beſide theſe, a great variety of other vegetable ſubſtances give out their colouring matter to water or alcohol, and are employed in dyeing. To what has now been ſaid, however, we ſhall only add a ſhort account of one of the moſt important, namely indigo.

2402 Indigo. 9. Indigo is a colouring matter which is obtained from ſeveral plants, and has ſome reſemblance to fecula or ſtarch. The indigo of commerce is chiefly obtained from the *indigofera tinctoria*, a ſhrubby plant which is cultivated in the Eaſt and Weſt Indies, for the purpoſe of extracting the colouring matter.

2403 Preparation. 10. When the indigo plant has arrived at maturity, it is cut down, and conveyed to large wooden veſſels, where it is covered with water, and ſoon commences a fermentation. When the plant is cut down at the period of its maturity, it produces a more beautiful colour, but in ſmaller quantity. If it be too late, the quantity is ſtill diminiſhed, and the indigo is of a bad quality. The putrefactive proceſs ſoon commences, and ſucceeds beſt about the temperature of 80°. The water becomes turbid, and of a green colour. The ſmell of ammonia and carbonic acid gas are evolved. The fermenting proceſs is finiſhed in the period of from 6 to 24 hours, according to the temperature and ſtate of the plant. The liquid is then poured off into flat veſſels, in which it is conſtantly agitated till blue flakes appear. With the addition of a quantity of lime-water theſe flakes precipitate to the bottom. A yellowiſh liquid is poured off, and the blue precipitate is collected in linen bags, from which the water drains off. When the matter in the bag has acquired ſufficient conſiſtence, it is formed into ſmall cakes, which are ſlowly dried in the ſhade. This is the indigo of commerce.

2404 From other plants. 11. Indigo may be alſo extracted from the *nerium tinctorium*, or roſebay, a plant which grows in abundance in the Eaſt Indies, from the leaves of which Dr Roxborough extracted it, by the following proceſs. He digeſted the leaves in a copper veſſel with water, kept at the temperature of 160° till they aſſumed a yellowiſh colour. The liquid becomes of a deep green; it is then poured off, and with the addition of lime-water is agitated till the indigo is precipitated. To produce one pound of indigo, two or three hundred pounds weight of green leaves were found neceſſary; but this quantity varies according to the ſeaſon and ſtate of weather in which they are collected.

2405 From woad. 12. The *iſatis tinctoria*, or woad, which is a Britiſh plant, alſo yields indigo, by treating it in the ſame way as the indigo plant.

2406 Hiſtory of indigo. 13. The hiſtory of indigo is curious. It was early known in India, but its value as a dye-ſtuff was not underſtood in Europe before the middle of the 16th century. But what is moſt ſingular, the uſe of this ſubſtance was either reſtricted or entirely prohibited in different countries, from ſome prejudice that its effects in dyeing were injurious. The uſe of it was prohibited in England from the time of Queen Elizabeth till the reign of Charles II. It was alſo prohibited in Saxony. It is deſcribed in the edict as a corroſive ſubſtance, and denominated *food for the devil!* In France during the adminiſtration of Colbert, the dyers were reſtricted to the uſe of a certain quantity. For ſome time after, indigo was generally employed as a dye ſtuff in Europe, and was chiefly cultivated in the Weſt Indies, and ſome parts of the American continent. This indigo was generally preferred in the market. What is now cultivated in the Eaſt Indies is found to be equal in quality.

2407 Properties. 14. Indigo is a light, friable ſubſtance, of a compact texture, and a deep blue colour. The ſhade varies from copper, violet, and blue tints. The lighteſt indigo is the beſt. It is always contaminated with extraneous matters. Bergman found in the pureſt indigo which he could procure, the following component parts. —

2408 Compoſition.

Pure indigo	47
Gum	12
Reſin	6
Barytes	10.2
Lime	10.0
Silica	1.8
Oxide of iron	13.0
	100.0

Other earths have been found in indigo. In ſome ſpecimens Prouſt detected magneſia.

2409 Action of heat. 15. Pure indigo is a ſoft powder of a deep blue colour, which has neither taſte nor ſmell. When expoſed to heat, it emits a bluiſh red ſmoke, and then burns away with a faint white flame. The earthy part remains behind in the ſtate of aſhes. It undergoes no change by expoſure to the air. It is inſoluble in water, but if kept ſome time under it, a fetid odour is exhaled, owing to ſome change.

2410 Of acids. 16. Diluted ſulphuric acid poured upon indigo diſſolves only the earthy and mucilaginous matters; but if concentrated ſulphuric acid be added, in the proportion of eight parts of acid to one of indigo, the latter is diſſolved with the evolution of heat, in about 24 hours. The mixure is black and opaque; but if water be added, it becomes clear, and of a fine blue colour, producing various ſhades, according to the quantity of water. This ſolution of indigo in ſulphuric acid is called *liquid blue*, or according to Bancroft, ſulphate of indigo.

2411 Effects of different ſubſtances on liquid blue. Bergman made a great number of experiments on the effect of different ſubſtances on this ſolution, ſome of which we ſhall now mention, in which the colour was either changed, or entirely deſtroyed. When it was dropped into ſulphurous acid, the colour which was at firſt blue, became green, and was at laſt deſtroyed. In diluted tartaric acid the colour became gradually green, and was at laſt converted into a pale yellow. In acetic acid it became green, and was at laſt deſtroyed. In potaſh, carbonate of potaſh, ſoda, ammonia and its carbonate, the colour became green, and at laſt diſappeared. In ſulphate of ſoda the ſolution being diluted, after ſome time became green. It alſo became green in ſulphate of iron, and at laſt diſappeared. In the ſulphurets the colour was very ſoon deſtroyed. Black oxide of manganeſe produced the ſame effect. Theſe experiments have been mentioned, to ſhew that indigo is deprived either partially or totally of its colouring matter, by thoſe ſubſtances which have a ſtrong affinity for oxygen. From this it is inferred that indigo owes its colour to oxygen; and that it becomes green when it is deprived of it.

2412 Nitric acid. Concentrated nitric acid attacks indigo with ſuch violence, that it ſometimes inflames it. By diluting the acid, the action is greatly moderated. The ſolution becomes of a brown colour; cryſtals appear, which are ſuppoſed to be oxalic acid, and a brown viſcid ſubſtance remains behind.

Muriatic acid diſſolves indigo precipitated from ſulphuric acid, and forms a liquid of a dark-blue colour. The other acids, as the phoſphoric, acetic, and tartaric, exhibited ſimilar phenomena. They readily diſſolve indigo, which has been precipitated.

Oxymuriatic acid has little action on indigo in ſubſtance, but it deſtroys the colour of it in the ſtate of ſolution.

2413 Of alcohol. 17. Neither alcohol, ether, nor oils, have any action on indigo. Common indigo, when digeſted with alcohol and ether, communicates a yellow colour; but this, it is ſuppoſed, is owing to the ſolution of the reſinous ſubſtance.

2414 Alkalies. 18. The ſolution of the fixed alkalies readily diſſolves indigo, when it is precipitated from its ſolution. The colour of the ſolution is at firſt green, and is at laſt deſtroyed. Liquid ammonia and its carbonate produce a ſimilar effect, from which it appears, that indigo is decompoſed by the alkalies.

19. Lime water alſo diſſolves indigo precipitated from its ſolution. The colour is at firſt green, becomes gradually yellow; when expoſed to the air, the green returns, and at laſt diſappears.

20. Bergman ſubjected indigo to the proceſs of diſtillation; from 576 grains he obtained the following products:

2415 Compoſition.

Carbonic acid gas - -	19
Yellow acid liquid containing ammonia	173
Oil - - -	53
Charcoal - - .	331
	576

The component parts of indigo, therefore, appear to be oxygen, carbone, hydrogen, and azote.

X. Of Bitter Matter.

2416 In different ſubſtances. 1. A great number of vegetable ſubſtances are diſtinguiſhed by a very bitter taſte, ſuch as quaſſia, a ſubſtance uſed in medicine, gentian, hops, chamomile. This taſte is aſcribed to a peculiar matter, called from this property *bitter matter*. It may be obtained by infuſing quaſſia for ſome time in water. This ſolution, which is of a yellow colour, has an extremely bitter taſte, but no ſmell. If the water be evaporated with a moderate heat to dryneſs, a browniſh yellow ſubſtance, which has ſome degree of tranſparency and ductility, remains behind. After ſome time it becomes brittle.

2417 Properties. 2. When this ſubſtance, which has a very bitter taſte, and a brown yellowiſh colour, is heated, it ſoftens, ſwells, and blackens, then burns away without much flame, and leaves a ſmall quantity of aſhes. It is very ſoluble in water and alcohol. Nitrate of ſilver renders it turbid, and afterwards produces a yellow precipitate in the form of flakes. Acetate of lead produces a copious white precipitate.

XI. Of Narcotic Matter.

2418 Found in different plants. 1. A peculiar ſubſtance has been detected in opium, to which it is ſuppoſed the properties it poſſeſſes of producing ſleep, are owing. On account of this property this ſubſtance has received the name of *narcotic matter*. It is obtained from the milky juices of ſome plants, as thoſe of the poppy, lettuce, and ſome others. Opium, which is extracted from the poppy, is prepared by the following proceſs.

2419 Extraction of opium. The heads of the *papaver album* or white poppy, which is cultivated in India and different countries of the eaſt for this purpoſe, are wounded with a ſharp inſtrument; a milky juice flows out, which concretes, and is collected and formed into cakes.

2420 Properties. 2. In this ſtate opium is a tenacious ſubſtance, of a browniſh colour, has a peculiar ſmell, and a diſagreeable bitter taſte. It becomes ſoft with a moderate heat. It readily takes fire, and burns rapidly. By the analyſis of opium, it appears to be compoſed of the ſulphates of lime and of potaſh, extractive matter, gluten, mucilage, reſinous matter, and an oil, beſides the narcotic matter to which its peculiar properties are owing.

2421 Separation of the narcotic matter. 3. By digeſting opium in water, part of it is diſſolved, and by evaporating the ſolution to the conſiſtence of ſyrup, a gritty precipitate appears, which becomes more copious with the addition of water. This precipitate is compoſed of reſinous and extractive matter, beſides the peculiar narcotic matter which is cryſtallized. When alcohol is digeſted on this precipitate, the reſinous and narcotic matters are diſſolved, and the extractive matter remains behind. As the ſolution cools, the narcotic matter cryſtallizes, but the cryſtals are coloured with a portion of reſin. By repeated ſolutions and cryſtallizations it may be obtained tolerably pure *.

2422 Of alcohol. If alcohol be digeſted on the reſiduum, it becomes of a deep-red colour; the ſame cryſtals are depoſited on cooling, and may be purified in the ſame way from the reſinous matter with which they are contaminated.

2423 Properties. 4. The narcotic matter, or, as it is called by Deroſne, the *eſſential ſalt of opium*, when properly purified, is of a white colour, cryſtallizes in right-angled priſms, with a rhomboidal baſe, and has neither taſte nor ſmell. It is inſoluble in cold water, and requires 400 parts of boiling water for its ſolution, from which it is precipitated by cooling. The ſolution does not redden the tincture of turnſole. It is ſoluble in 24 parts of boiling alcohol, and requires about 100 parts when it is cold. When water is added to the ſolution in alcohol, it is precipitated in the form of a white opaque matter.

2424 Action of ether, &c. Ether and the volatile oils diſſolve this ſalt with the aſſiſtance of heat; but on cooling it is depoſited in the form of an oily liquid, and ſome time after cryſtals appear at the bottom of the veſſel.

2425 Of acids. 5. One of the moſt decided characters of this ſubſtance is its eaſy ſolubility in all the acids, and without the aid of heat. It is precipitated from theſe ſolutions by means of an alkali, in the form of white powder. Pure alkalies increaſe the power of its ſolubility in water; and the acids, when not added in exceſs, occaſion a precipitate. When nitric acid is poured on the cryſtals reduced to a coarſe powder, it communicates to them a red colour, and readily diſſolves them. When the ſolution is heated and evaporated, it yields cryſtals of oxalic acid in conſiderable quantity. The reſiduum has a very bitter taſte.

2426 Of heat. 6. When it is thrown on burning coals, it gives out a copious flame. When heated in a ſpoon, it gradually melts like wax. Diſtilled in a retort with a moderate heat, it melts, and afterwards ſwells up, with the evolution of white vapours, which condenſe on the ſides of the veſſel, in the form of a yellow oily matter. There paſſes over, at the ſame time, a little water impregnated with carbonate of ammonia. Towards the end of the proceſs, carbonic acid and carbonated hydrogen gas, with ſome ammonia, are diſengaged. There remains in the retort a light, ſpongy, voluminous maſs of charcoal, which, by burning, gives ſome traces of potaſh. The oily matter depoſited in the neck of the retort is very viſcid, and has a ſtrong aromatic odour, with a pungent, acrid taſte.

2427 Effects on animals. 7. Deroſne tried the effects of this ſubſtance on animals, and in very ſmall quantity. The ſymptoms which appeared, when it was given to dogs, were exactly ſimilar to thoſe which are produced, when a large quantity of crude opium is ſwallowed. They were recovered from its effects by means of vinegar, which he accounts for on the principle of the eaſy ſolubility of this ſubſtance in acids.

2428 Compoſition. 8. From the effects of heat and of nitric acid on this ſubſtance, it appears to be compoſed of oxygen, hydrogen, carbone, and azote.

2429 Opium found in other plants. 9. This narcotic ſubſtance is alſo found in the milky juice, and in the extracts which are obtained from ſeveral other plants, as from different ſpecies of *lactuca* or lettuce, *hyoſcyamus niger*, or henbane. The leaves of ſome plants alſo produce ſimilar effects, as thoſe of the *deadly nightſhade*, *fox-glove*, and *conium maculatum* or hemlock.

XII. Of Oils.

2430 Fixed. 1. The nature, properties, and component parts of oils, have already been detailed, when treating of inflammable ſubſtances. Oils are of two kinds, fixed and volatile. Fixed oil exiſts chiefly in the ſeeds of plants, as linſeed oil, almond oil, and rape-ſeed oil. Fixed oil is alſo found in the pulp of ſome fruits, as in that of the olive. Fixed oils are found in thoſe ſeeds which have double lobes, or two cotyledons, and in theſe they are mixed with a quantity of mucilage. Theſe oils are extracted from ſeeds by expreſſion and boiling.

2431 Volatile. 2. Volatile oils are found in all parts of plants, excepting the ſeeds. In ſome plants they exiſt in the root, or the ſtem, and in others in the leaves, the flower, the pulp and rind of the fruit. The peculiar odour by which almoſt all plants are diſtinguiſhed, is ſuppoſed to be owing to a volatile oil. Theſe oils are alſo extracted by expreſſion, and ſometimes by diſtillation.

XIII. Of Wax.

2432 Preparation. 1. Wax of which bees form their combs for containing honey, is collected from vegetables; and a ſimilar ſubſtance being found in different parts of plants, it is to be conſidered as vegetable matter. The varniſh with which the upper ſurface of the leaves of ſome trees is covered, poſſeſſes the properties of bees wax. If the bruiſed leaves are digeſted in water, and afterwards in alcohol, till the ſoluble part is extracted, and the reſiduum be mixed with 6 times its weight of a ſolution of ammonia, and after maceration, the ſolution being poured off and filtered, diluted ſulphuric acid be added in exceſs to ſaturate the alkali, conſtantly ſtirring it, the varniſh precipitates in the form of a yellow powder. It is then to be waſhed with water, and melted with a moderate heat. This ſubſtance is wax.

2433 Properties. 2. Pure wax is of a white colour, has no taſte, and ſcarcely any ſmell. The aromatic ſmell of bees wax is owing to ſome ſubſtance with which it is mixed, for it is entirely removed by expoſure to the air, when the colour at the ſame time diſappears. Pure wax undergoes no change by expoſure to the air. The ſpecific gravity is 0.96. It is inſoluble in water.

2434 Action of heat. 3. Wax becomes ſoft by the application of heat. Unbleached wax melts at the temperature of 142°. When it is pure it requires the temperature of 155°, and then melts into a colourleſs, tranſparent fluid. By increaſing the heat, the wax boils and evaporates; with a red heat the vapour takes fire, and burns with a bright flame.

2435 Acids. 4. The acids have ſcarcely any action on wax. It is bleached by means of oxymuriatic acid, but no other effect is produced.

2436 Alcohol, &c. 5. Wax is ſoluble in boiling alcohol. It requires 20 parts of alcohol to diſſolve one of wax, and as the ſolution cools, the greater part is precipitated. With the addition of water the whole is thrown down. With the aſſiſtance of heat ether diſſolves wax nearly in the ſame proportion, but on cooling it is alſo precipitated.

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* Ann. de Chim. xlv. 263.

Wax is ſoluble in the fixed oils with the aid of heat. This compound is known by the name of *cerate*, which is much employed to form plaſters for dreſſing wounds. It is ſoluble alſo in ſome of the volatile oils, as thoſe of turpentine, with the aſſiſtance of heat. As the ſolution cools, part of the wax is precipitated.

2437 Alkalies. 6. Wax combines with the fixed alkalies, and forms with them ſubſtances ſimilar to ſoap.

2438 Compoſition. 7. According to the analyſis of Lavoiſier, wax is compoſed of

Carbone,	82.28
Hydrogen,	17.72
	100.00

2439 Butter of wax. 8. When wax is diſtilled with a temperature above 212°, water comes over, ſome acid, and a little fluid and odorous oil. The oil in the courſe of the proceſs becomes thicker, and at laſt aſſumes the conſiſtency of butter; and hence it has been called *butter* of wax. This ſubſtance by repeated diſtillation is converted into a volatile oil. A coaly matter remains in the retort.

2440 Obtained from many plants. 9. Wax is extracted from a number of plants, poſſeſſing different degrees of conſiſtency, as that from the cacao, called the *butter of cacao;* from the *croton ſebifera*, called the *tallow of croton*; and the myrtle wax extracted from the *myrica cerifera*, or *candle-berry myrtle* of America. The myrtle wax is obtained from the berries of this plant. They are collected and put into a kettle, and covered with water to the depth of half a foot. Heat is applied, and the berries are preſſed againſt the ſides of the veſſel. The wax melts, and ſwims on the top. It is collected, paſſed through a cloth, dried and melted again, and then caſt into cakes. The wax, it appears, exiſts chiefly in the outer covering of the berries. Myrtle wax is of a pale-green colour; the ſpecific gravity is 1.015. When heated to the temperature of 109°, it melts; with a ſtronger heat it burns, giving out a white flame with little ſmoke; an agreeable aromatic odour is at the ſame time emitted. In its other properties it reſembles bees wax.

Prouſt has detected wax in the rind of plums, oranges, and ſimilar fruits, and in the green fecula of many plants.

XIV. Of Camphor.

2441 Extraction. 1. Camphor is obtained from the *laurus camphorata*, a ſpecies of laurel which grows in China and Japan. It is extracted by ſublimation in an iron pot. The Dutch afterwards purify it by a ſecond ſublimation.

2442 Properties. 2. It is a white, brittle ſubſtance, poſſeſſing a hot acrid taſte. The ſpecific gravity is 0.9887. It is not altered by expoſure to the air, but it is ſo extremely volatile, that it diſappears entirely if left in an open veſſel. It cryſtallizes by ſublimation in cloſe veſſels, in the form of hexagonal plates or pyramids. It is inſoluble in water, although at the ſame time it communicates ſome of its odour.

2443 Action of heat. 3. When a heat about the temperature of 300° is ſuddenly applied, it melts, and then is volatilized. It readily catches fire, and burns with a bright flame, without leaving any reſiduum. It even burns on the ſurface of water. When a ſmall quantity of camphor in a ſtate of inflammation is introduced into a large glaſs veſſel filled with oxygen gas, it burſts out into a vivid flame; the inſide of the veſſel is covered with a black powder, and a great deal of carbonic acid gas is diſengaged. If a little water has been previouſly put into the veſſel, it is impregnated with carbonic and camphoric acids.

4. Camphor is ſoluble in the acids, but with the addition of water or an alkali, it is precipitated unchanged. Camphor in ſulphuric acid forms a red ſolution; in nitric acid, a yellow ſolution, which was formerly called *oil of camphor*. By the repeated diſtillation of nitric acid off camphor, it is converted into camphoric acid. 2444 Acids.

Sulphurous acid, muriatic acid, and fluoric acid, in the ſtate of gas, diſſolve camphor. If oxymuriatic acid gas be made to paſs into a ſolution of camphor in nitric acid, it is immediately changed to a roſe colour, and inſtantly afterwards it becomes yellow, which is permanent during the proceſs. When water is added to the ſolutions of camphor in acids, it is ſeparated. Camphor is alſo ſoluble in water impregnated with carbonic acid gas, and in acetic acid. The latter compound conſtitutes Henry's aromatic vinegar.

5. Alcohol readily diſſolves camphor, but it is precipitated with the addition of water. By diluting alcohol which holds camphor in ſolution with water, juſt ſo much as not to precipitate the camphor, the latter cryſtallizes in the form of feathers. The fixed and volatile oils diſſolve camphor with the aſſiſtance of heat, but on cooling the camphor is precipitated, and cryſtallized, as in the ſolution with alcohol.

6. Camphor communicates to the alkalies a little of its colour, but is not otherwiſe ſoluble in theſe bodies. 2445 Alkalies.

7. According to the analyſis of Bouillon Lagrange, by diſtilling one part of camphor with two of alumina, formed into a paſte with water in a glaſs retort, the component parts of camphor are carbone and hydrogen; the proportion of carbone being much greater than in oils. 2446 Compoſition.

In the courſe of the diſtillation, he obtained a volatile oil, of a golden yellow colour, which floated on the ſurface of the water in the receiver. It had an acrid burning taſte, and aromatic odour, ſimilar to that of thyme or roſemary. 2447 Oil of camphor.

8. Camphor has been detected in many other plants. It has been extracted from the roots of thyme and ſage, and in theſe plants it ſeems to be combined with volatile oil. If the oil be expoſed to a temperature below 54° in the open air, it evaporates, and the camphor cryſtallizes. It may be alſo obtained by diſtilling the oil in a water bath, under the temperature of 212°, till a third part of the oil paſſes over. Part of the camphor is found cryſtallized in the veſſel, and by repeating the proceſs, the whole may be extracted from the oil. By mixing the camphor with a little dry lime, and ſubliming it, it may be purified. 2448 Found in many plants.

XV. Of Caoutchouc.

1. Caoutchouc is a ſoft elaſtic ſubſtance, chiefly obtained 2449 History.

tained from the inſpiſſated juice of two trees, the *hævea caoutchouc* and *jatropha elaſtica*, which are natives of South America. This ſubſtance was firſt brought from America about the beginning of the 18th century. It is called by the inhabitants of *Eſmeraldas*, a province of Quito, *heve*, and by the natives of the province of Mainas, *caoutchouc*.

2450 Preparation. 2. It is extracted by making inciſions in the bark of the tree. A milky juice flows from it, which is collected in proper veſſels. The juice is then applied, one ſtratum above another, on earthen moulds, and ſuffered to dry in the ſun, or before a fire. Various figures are formed on the ſurfaces of the different pieces by means of a pointed inſtrument. They are then expoſed to ſmoke, and, when perfectly dry, the moulds are broken. In this ſtate it is brought to Europe. It is generally in the ſhape of bottles, but ſometimes in other forms.

2451 Properties. 3. When caoutchouc is pure, it is of a whitiſh colour; it is ſoft and pliable like leather, extremely elaſtic, and poſſeſſes great tenacity. The ſpecific gravity is 0.9335.

2452 Action of heat. 4. When caoutchouc is expoſed to heat, it readily melts into a matter of the conſiſtence of tar. It burns with a bright white flame, and diffuſes a fetid odour.

5. Sulphuric acid decompoſes caoutchouc; charcoal is precipitated, and the acid is partially converted into ſulphurous acid. It is alſo decompoſed by nitric acid; carbonic acid gas, azotic gas, and pruſſic acid gas are diſengaged, and oxalic acid is formed. Muriatic acid has no action upon it; but if oxymuriatic acid is poured upon the milky juice, the caoutchouc is immediately precipitated, and the acid is converted into muriatic acid. If a given quantity of air be confined in a veſſel over a quantity of this milky juice, the oxygen of the air is abſorbed, and a pellicle of caoutchouc is formed on the ſurface, from which it appears that the formation of caoutchouc is owing to the combination of its baſe with oxygen.

2453 Alcohol. 6. Caoutchouc is inſoluble in alcohol. It is ſoluble in ether, but it is neceſſary that the ether be previouſly waſhed with water. By this treatment it is formed into ſyringes, catheters, and other inſtruments. It is ſoluble in the volatile oils, but it remains ſomewhat glutinous after the evaporation. A mixture of volatile oil and alcohol forms a good ſolvent for caoutchouc, and in this ſtate it may be employed as a varniſh for paper or ſtuffs. A varniſh may alſo be formed with it by diſſolving it in boiling wax. It is alſo ſoluble in rectified petroleum, and when the ſolution is evaporated, the caoutchouc remains unchanged.

2454 Alkalies. 7. According to ſome, caoutchouc is inſoluble in the alkalies; but according to others, all of theſe bodies are capable of diſſolving it.

2455 Compoſition. 8. By diſtillation caoutchouc yields ammonia; and from this, and its decompoſition by means of ſulphuric and nitric acids, its conſtituent parts muſt be carbone, hydrogen, azote, and oxygen.

2456 Found in different vegetables. 9. Caoutchouc has been detected in different parts of many other plants, but it is mixed with reſinous, gummy, and extractive matters. It has been found in different ſpecies of the miſletoe, in opium and maſtic. It has alſo been extracted from the *artocarpus integrifolia* or bread-fruit tree, the *urceola elaſtica*, and *ficus indica*.

XVI. Of Reſins.

2457 Nature of. 1. Reſinous bodies form a very numerous claſs of vegetable ſubſtances. When volatile oils are expoſed to the air, they become thick after a ſhorter or longer time, and are then found to be converted into a *reſin*. The oil abſorbs oxygen from the air, and is deprived of part of its carbone, which combining with the oxygen of the atmoſphere, forms carbonic acid. Reſinous ſubſtances, therefore, are generally conſidered as volatile oils ſaturated with oxygen. The general properties of reſinous ſubſtances are the following.

2458 Properties. 2. They are ſolid, brittle, and commonly of a yellowiſh colour, with ſome degree of tranſparency. The taſte reſembling volatile oils, is hot and acrid. They have no ſmell. The ſpecific gravity is from 1.0180 to 1.2289. All reſinous bodies are electrics, and when excited by friction, the electricity is negative; hence it is called *reſinous electricity*.

2459 Action of heat. 3. They melt by being expoſed to heat, and burn with a yellow flame, giving out a great quantity of ſmoke. Reſins are inſoluble in water.

2460 Acids, &c. 4. Reſinous ſubſtances are ſoluble in nitric acid; part is precipitated by the addition of water, and the whole by means of the alkalies. With the aſſiſtance of heat they are all ſoluble in alcohol, and in ſulphuric ether. Reſins are ſoluble in ſome of the fixed oils, and alſo in volatile oils.

2461 Alkalies. 5. Reſinous ſubſtances have been found to be ſoluble in the fixed alkalies.

6. We ſhall now enumerate ſome of the reſins which are beſt known.

2462 Roſin. *Roſin.*—This ſubſtance is extracted from different ſpecies of the fir, and the reſinous matter obtained from it has received different names. That procured from the *pinus ſylveſtris* is the common turpentine; from the *pinus larix*, venice turpentine; and from the *pinus balſamea*, balſam of Canada. The turpentine is obtained by ſtripping the bark off the trees; a liquid juice flows out, which gradually hardens. This juice conſiſts of oil of turpentine and roſin. By diſtilling the turpentine the oil paſſes over, and the roſin remains behind. By diſtilling to dryneſs common roſin is obtained. When water is added, while it is yet fluid, and incorporated by agitation, what is called yellow roſin is formed.

2463 Pitch. *Pitch*—Is a reſinous juice obtained from the *pinus picea*, or pitch pine. It is purified by melting and ſqueezing it through linen bags, and it is then known by the name of *white* or *Burgundy pitch*. White pitch mixed with lamp-black forms black pitch.

2464 Maſtic. *Maſtic.*—This is a reſinous ſubſtance obtained from the *piſtacia lentiſcus*, a tree which grows in the Levant. The fluid which exudes from the tree, concretes into yellowiſh ſemitranſparent brittle grains. It has little taſte, melts and exhales a fragrant odour when heated, and readily diſſolves in alcohol and fixed oils. It contains a little volatile oil.

2465 Sandarac. *Sandarac.*—This reſinous ſubſtance is extracted from the juniper. It is a ſpontaneous exudation from this plant in the form of brown tears, which are ſemitranſparent and brittle.

2466 Labdanum. *Labdanum*, or *Ladanum*.—This is the produce of the *ciſtus creticus*, a ſhrub which grows in Candia. It is the exudation of a viſcid juice, which concretes by expoſure to the air. It has a fragrant odour and a bitter taſte.

2467 Dragons-blood. *Dragons-blood*.—This reſinous ſubſtance is a production of the *dracæna draco*, and ſome other plants. It is of a dark-red colour, opaque and brittle. The powder is of a crimſon colour. It melts when it is heated, and readily burns. It has no taſte, is inſoluble in water, but ſoluble in alcohol, to which it communicates a crimſon colour. It is alſo ſoluble in the fixed oils, and gives them a red colour.

2468 Anime. *Reſina animæ*.—This reſin is the produce of a ſpecies of *hymenæa*, or locuſt tree, a native of North America. It is ſoluble in alcohol, and is employed as a varniſh.

2469 Copal. *Copal*.—This reſinous ſubſtance is obtained from a tree, the *rhus copallinum*, a native of North America. The copal moſt preferred is brought from Spaniſh America. It is a light brown, tranſparent ſubſtance. It melts when heated, but is not directly ſoluble in alcohol, or in oil of turpentine, and it is with difficulty ſoluble in fixed oils. Copal forms an excellent varniſh. Indeed it is one of the beſt that is known for beauty and durability.

2470 Varniſh. If copal be treated with oil of turpentine in a cloſe veſſel, from which the vapours are not allowed to eſcape, they exert a great preſſure, which prevents the boiling, and thus the mixture acquires a higher temperature. A conſiderable portion of the copal is thus diſſolved, and with the addition of a little poppy oil it forms an excellent elaſtic varniſh.

If copal be kept melted till a four-ſmelling aromatic odour ceaſes to proceed from it, and if it be then mixed with an equal quantity of linſeed oil previouſly rendered colourleſs by expoſure to the ſun, it combines with the oil, and thus forms a varniſh. The ſubſtances varniſhed with this preparation muſt be dried in the ſun.

Copal may be diſſolved in alcohol, by previouſly diſſolving half an ounce of camphor in 16 ounces of alcohol. This ſolution is poured on 4 ounces of copal in a matraſs, which is ſtopped with a cork, and perforated with a pin. When the copal is nearly diſſolved, the proceſs is ſtopped, and the matraſs allowed to cool, before the cork is removed. This ſolution forms a colourleſs varniſh.

Copal, it is ſaid, may be diſſolved in alcohol, by expoſing it to the action of the vapour. This proceſs is conducted by boiling a quantity of alcohol in the bottom of a veſſel, at the top of which a piece of copal is ſuſpended. During the proceſs the copal ſoftens, and falls down like oil into the alcohol.

2471 Elemi. *Elemi*.—This reſinous ſubſtance is the produce of the *amyris elemifera*, a tree which grows in the Eaſt and Weſt Indies. It is ſemitranſparent, of a pale yellow colour, ſoftiſh, and hardens by keeping. It has a ſtrong fragrant ſmell, and when diſtilled it yields a fragrant oil.

2472 Balm of Gilead. *Opobalſamum*, or *balm of Gilead*.—This reſin is procured from another ſpecies of amyris, the *Gileadenſis*, a tree which is a native of Arabia. The beſt kind, which is highly valued by the Turks, is never ſeen in Europe.

2473 Copaiva. *Copaiva*, or *balſam of Copaiva*.—This reſinous ſubſtance is obtained from the *copaiva officinalis*, a tree which is a native of South America. It exudes by wounding the trunk of the tree. It is tranſparent, of a yellowiſh colour, has a pungent taſte, and an agreeable ſmell. It is at firſt of the conſiſtence of oil, but afterwards becomes as thick as honey. By diſtillation the volatile oil, with which it is mixed, may be ſeparated, and the reſinous matter remains behind.

2474 Guaiac. *Guaiac*.—This reſin is the produce of the *guaiacum officinale*, a tree which is a native of the Weſt Indies. The reſin exudes ſpontaneouſly in tears, but it is chiefly obtained by cutting the wood into billets, and boring them longitudinally. When one of theſe is heated on the fire, the reſinous matter is melted, and runs through the hole as the wood burns. This reſin is of a browniſh-yellow colour, and has ſome degree of tranſparency. It is ſoluble in alcohol, and has neither ſmell nor taſte. It melts when heated, and when it is thrown on hot coals, it diffuſes an agreeable odour. When ſwallowed in the ſtate of powder, it produces a ſtrong ſenſation of heat in the throat.

2475 Lac. *Lac*.—This reſinous ſubſtance is obtained from the *croton lacciferum*. It is of a deep red colour, with ſome degree of tranſparency. It is the baſis of the finer kinds of ſealing wax, and is employed as a varniſh.

2476 Amber. *Amber*.—This ſubſtance poſſeſſes many of the properties of the reſins, and it has been conſidered by ſome of vegetable origin. It is a brittle hard ſubſtance, tranſparent, ſometimes colourleſs, but often yellow or deep brown. The ſpecific gravity is 1.065. It has neither taſte nor ſmell, except when it is heated, and then it becomes ſoft, and gives out a fragrant odour. It burns with a ſtrong heat, leaving only a ſmall reſiduum. It is inſoluble in water, but alcohol diſſolves a ſmall quantity of it. When the ſolution is concentrated, it becomes milky with the addition of water. The precipitate which is formed is a reſinous ſubſtance. It is ſoluble in the fixed alkalies at a boiling temperature.

2477 Effect of acids. Sulphuric acid converts amber into a black reſinous maſs. It is alſo ſoluble in nitric acid.

2478 Diſtillation. By the diſtillation of amber, carbonic acid gas and carbonated hydrogen gas, an acid liquor, and an oil, which is at firſt thin and tranſparent, but afterwards larger and thicker, is obtained. Succinic acid ſublimes towards the end of the proceſs.

2479 Varniſh. When amber is roaſted, it becomes ſoluble in the oils, and forms a varniſh. This varniſh may be formed by ſpreading the amber on a flat-bottomed iron pan, and expoſing it to heat till it melts. It is then covered up, and ſet by to cool. One part of this roaſted amber, which has loſt half of its weight, if the proceſs be properly managed, is then to be mixed with three parts of linſeed oil. The mixture is to be expoſed to a gentle heat till the amber is diſſolved. It is then to be removed from the fire, and four parts of the oil of turpentine are to be added when it is nearly cold. The clear part, after it has ſettled, is ſtrained through a linen cloth.

2480 Benzoin. *Benzoin*.—This ſubſtance contains a reſinous matter combined with an acid, and is commonly ranked among balſams. Benzoin is obtained from the *ſtyrax benzoin*, a tree which is a native of Sumatra. It is a brittle ſubſtance, has a fragrant odour when rubbed, and, when it is heated, the acid eſcapes. It may be diſſolved in alcohol, but it is inſoluble in water.

2481 Styrax. *Styrax.*—This ſubſtance, which is in a half-fluid ſtate, exudes from a tree in Arabia. It is of a greeniſh colour, has an aromatic taſte, and an agreeable odour. The benzoic acid, which is one of its component parts, diſſolves in water. The whole of it is ſoluble in alcohol. It abſorbs oxygen, and becomes harder by expoſure to the air.

2482 Storax. *Storax.*—This ſubſtance is procured from the *ſtyrax officinale*, a tree which is a native of the Levant. It is of a brown colour and brittle, has an aromatic taſte, fragrant odour, and is ſoluble in alcohol. It gives out benzoic acid by heat.

2483 Balſam of Tolu. *Balſam of Tolu.*—This ſubſtance is obtained from the *toluifera balſamum*, a tree which is a native of South America. It is of a reddiſh-brown colour, becomes ſolid and brittle when expoſed to the air, and has a very fragrant ſmell.

2484 Of Peru. *Balſam of Peru.*—This is obtained from the *myroxilon peruiferum*, a plant which is a native of South America. The reſin is extracted by boiling the twigs in water. It is of the conſiſtence of honey, has a brown colour, an agreeable ſmell and an acrid taſte. It is ſoluble in alcohol. The acid part is ſoluble in water. Benzoic acid is driven off by heat.

XVII. Of Gum-Reſins.

2485 Conſtituents. 1. This claſs of ſubſtances ſeems to be compoſed of a mixture of reſinous matter with a portion of gummy and extractive matter. They are never obtained from plants by means of ſpontaneous exudation, but are procured by wounding the plants which contain them. The general properties of gum-reſins are the following.

2486 Properties. 2. They are always in the ſolid ſtate, and commonly brittle and opaque. They are ſoftened by heat, but do not melt, and are leſs combuſtible than the reſins. They burn with flame. They have an acrid taſte, with a ſtrong ſmell, ſomewhat reſembling garlic. They are partially ſoluble in water, and in alcohol. The ſolution in water is opaque and milky, and the ſolution in alcohol is tranſparent. They are partially ſoluble in vinegar and wine. They are ſoluble in nitric acid, and alſo in the alkalies, with the aſſiſtance of heat.

3. The gum-reſins by diſtillation yield a portion of ammonia, which ſhews that azote forms one of their conſtituent parts.

4. Many of the gum-reſins have been long known in medicine, and ſome of them are of conſiderable importance. We ſhall ſpecify the peculiar properties of the following.

2487 Olibanum. *Olibanum.*—This gum-reſin is chiefly collected in Arabia, from the *juniperus lycia*. It is brought from Mecca to Cairo, and from thence to Europe, in the form of tranſparent brittle grains, not larger than a cheſnut, of a yellow colour, a peculiar aromatic ſmell, but with little taſte. With water it forms a milky fluid, but it is entirely ſoluble in alcohol. When heated it does not melt, but inflames and burns with an agreeable ſmell. It is the frankincenſe of the ancients, and is ſtill employed to diffuſe an agreeable fragrance in the Greek and Romiſh churches.

2488 Scammony. *Scammony.*—This ſubſtance is extracted from the *convolvulus ſcammonia*, a climbing perennial plant which grows in Syria. By cutting the roots, a milky juice flows out, which is collected and dried in the ſun. It is of a dark-gray colour, a bitter acrid taſte, and a nauſeous ſmell. It forms a greeniſh milky fluid with water. It is ſoluble in alcohol. It is employed in medicine as a cathartic.

2489 Euphorbium. *Euphorbium.*—This ſubſtance is obtained from the *euphorbia officinalis*, which is a native of Ethiopia. The milky juice which flows from inciſions made in the plant, is dried in the ſun. It is in the form of ſmall yellow tears. It has no ſmell, and at firſt no perceptible taſte, but it communicates afterwards a burning ſenſation to the mouth. It is ſoluble in alcohol. It has been conſidered as poiſonous.

2490 Aſſafœtida. *Aſſafœtida.*—This gum-reſin is obtained from the *ferula aſſafœtida*, a perennial plant, which is a native of Perſia. It is extracted from the roots by cutting off the extremity. The milky juice flows out, which is dried in the ſun. It is brought to Europe in large irregular maſſes, which are of a whitiſh, reddiſh, or violet hue. It has a ſtrong fetid, alliaceous ſmell, and a bitter acrid taſte. It is but partially ſoluble, both in alcohol and in water. It is much employed in medicine as a ſtimulant and antiſpaſmodic.

2491 Ammoniac. *Ammoniac.*—This gum-reſin is ſuppoſed to be obtained from another ſpecies of the ferula, a plant which grows in Abyſſinia and in the interior parts of Egypt. It is brought from the Eaſt Indies, uſually in large maſſes, which are compoſed of little lumps or tears, of a milky colour. When expoſed to the air, it is changed to a yellow colour. It has a nauſeous, ſweet taſte, which is ſucceeded by a bitter. It has a peculiar ſmell. It is not fuſible; but when placed on hot coals, it burns away in flame. It forms a milky ſolution with water and vinegar, and it is partially ſoluble in alcohol.

2492 Myrrh. *Myrrh.*—It is not yet known from what plant this ſubſtance is obtained. It is brought from the Eaſt Indies in the form of tears; is light and brittle, of a reddiſh-yellow colour, and an unctuous feel. It has a bitter aromatic taſte, and a ſtrong, but ſomewhat grateful odour. It does not melt, and burns with difficulty. It is more ſoluble in water than in alcohol. With the former the ſolution is yellow and opaque; with the latter it is tranſparent.

2493 Sarcocol. *Sarcocol.*—This ſubſtance is ſuppoſed to be the product of the *penæa ſarcocolla*. It is brought from Perſia and Arabia, in the form of ſmall whitiſh-yellow grains. It has a bitter and ſomewhat ſweetiſh taſte. It is almoſt entirely ſoluble in water.

2494 Galbanum. *Galbanum.*—This ſubſtance is obtained from the *bubon galbanum*, a perennial plant which grows in Africa. The milky juice ſometimes exudes from the joints of the old plants, but is moſt commonly procured by cutting them acroſs. This juice becomes hard, and is the galbanum brought to Europe. It is in the form of whitiſh-yellow tears, has a bitteriſh acrid taſte, and a peculiar ſmell. It forms a milky ſolution with water, wine, and vinegar. It is ſcarcely ſoluble in alcohol.

It does not melt, but yields a conſiderable proportion of oil by diſtillation.

2495 Sagapenum. *Sagapenum.*—It is only conjectured that this gum reſin is obtained from the *ferula perſica*. It is brought in large maſſes or diſtinct tears from Alexandria. It is of a yellow colour, becomes hot in the hand, but is not fuſible. It has a hot, nauſeous, bitteriſh taſte, and a diſagreeable garlic ſmell. It is ſparingly ſoluble in alcohol, but diſſolves almoſt entirely in water. It yields by diſtillation a fetid volatile oil.

2496 Opoponax. *Opoponax.*—This gum-reſin is obtained from the *paſtinaca opoponax*, a perennial plant which grows wild in the ſouth of Europe. It is obtained by wounding the ſtock or root, and is in the form of round drops or tears, or in irregular maſſes of a reddiſh-yellow colour. It has a bitter, acrid, and ſomewhat nauſeous taſte, with a ſtrong peculiar ſmell. It forms a milky ſolution with water, and yields an eſſential oil by diſtillation.

2497 Gamboge. *Gamboge.*—This gum-reſin is obtained from the *ſtalagmitis cambogioides*, a tree which grows wild in Siam and Ceylon. In Siam it is procured in drops by breaking the leaves and young ſhoots, from which it is ſuppoſed to derive the name of *gum guttæ*. It Ceylon it is obtained by wounding the bark and collecting the juice, which is afterwards dried in the ſun. It is brought from the Eaſt Indies in cakes or rolls. It is of a yellow-orange colour, opaque and brittle, has no ſmell, and little taſte, leaving only a ſlight ſenſe of acrimony when it has been kept in the mouth. It forms a turbid yellow ſolution with water, and is almoſt entirely ſoluble in alcohol. It is employed in medicine, and is a violent cathartic.

2498 Bdellium. *Bdellium.*—Little is known of this ſubſtance, or of the tree from which it is obtained. It is in the form of ſmall pieces or tears of different ſizes, of a golden-yellow colour, with a reddiſh tint. This ſubſtance, or a ſubſtance with the ſame name, was long celebrated among the ancient phyſicians.

XVIII. Of Wood.

2499 Preparation. 1. If a piece of wood be boiled in a great quantity of water till it no longer gives out taſte or ſmell, and if it be afterwards digeſted in alcohol, the ſubſtance which remains is the woody fibre.

2500 Properties. 2. It is either in a fibrous, lamellated, or pulverulent form. This ſubſtance, which is more or leſs coloured, has neither taſte nor ſmell, is not altered by expoſure to the air, and is inſoluble in water and alcohol.

2501 Action of heat. 3. When it is heated in contact with air, it blackens, exhales denſe, acrid, pungent fumes, and leaves behind a coaly matter, which does not change its form. By reducing it to aſhes, it is found to contain a little potaſh, ſulphate of potaſh and lime, and phoſphate of lime. When it is diſtilled in a retort it yields water, acetic acid contaminated with oil, a thick oily matter, carbonated hydrogen and carbonic acid gaſes, and a portion of ammonia, combined with acetic acid.

2502 Compoſition. 4. By the action of nitric acid on quinquina, which reſembles the woody fibre, Fourcroy obtained from 100 parts, the following products:

Oxalic acid,	56.250
Citric acid,	3.905
Malic acid,	0.388
Acetic acid,	0.486
Azotic acid,	0.867
Carbonate of lime,	8.330
	70.226
Reſiduum,	32.031

A quantity of carbonic acid gas was alſo diſengaged, which was not eſtimated. The increaſe of weight is aſcribed to the oxygen which combined with the baſes of the acids which were formed during the decompoſition of the woody fibre by the nitric acid. The reſiduum, by diſtillation, yielded a yellowiſh fluid mixed with alcohol and ſome acetic acid, a concrete oil ſoluble in alcohol, charcoal, and carbonate of lime, beſides carbonic acid and carbonated hydrogen gaſes. The component parts of wood, therefore, appear to be, oxygen, carbone, hydrogen, azote, and lime.

2503 Proportions of charcoal. The relative proportion of wood in plants has been eſtimated by the proportion of charcoal which they afford. From different woods, Prouſt obtained charcoal in the following proportions.

Black aſh,	25
Guaiac,	24
Pine,	20
Green oak,	20
Heart of oak,	19
Wild aſh,	17
White aſh,	17

XIX. Of Tan.

2504 Preparation. 1. Tan is obtained from a great number of vegetable ſubſtances. It exiſts in conſiderable proportion in oak bark and nut-galls; and it is obtained from the latter by the following proceſs.

Reduce a quantity of nut-galls to a coarſe powder, infuſe them in water till it is ſaturated, pour off the liquid, and boil it to dryneſs. A black matter remains, which is *tan*, nearly in a ſtate of purity. It is propoſed alſo to extract tan from nut-galls by other proceſſes. If a ſolution of muriate of tin be added to the infuſion of nut-galls, a copious precipitate of a yellow colour is produced. When this is ſeparated by filtration, and dried, it is in the form of a buff-coloured powder. It is a compound of oxide of tin and tan. It is then mixed with water, and a ſtream of ſulphurated hydrogen gas is paſſed through it. An inſoluble ſulphuret of tin is formed, and the tan is diſſolved in water. By filtration and evaporation of this water to dryneſs, a brown ſubſtance remains, which is tan; but by this proceſs it is not perfectly pure, being mixed with a portion of extractive matter. It has alſo been propoſed to ſeparate tan from the infuſion of nut-galls by means of concentrated ſulphuric or muriatic acid, carbonate of potaſh, or lime water.

2505 Properties. 2. Tan is a brittle ſubſtance, of a brown colour, has a very aſtringent taſte, is ſoluble in water and alcohol, to both of which it communicates a brown colour and very aſtringent taſte.

2506 Action of heat. 3. When it is heated, it becomes black, gives out carbonic acid gas, and burns in the open air, leaving behind a ſmall quantity of lime.

2507 Acids. 4. Tan is precipitated from the infuſion of galls, by means of ſulphuric, nitric, and muriatic acids, and forms with them compounds which are ſoluble in water.

2508 Alkalies.

5. The alkalies combine with tan, and form compounds which are ſoluble in water. A reddiſh brown colour is produced in the liquid by the addition of potaſh or ſoda, and it loſes the property of precipitating gelatine. Ammonia forms a ſimilar compound with the infuſion of galls.

2509 Earths.

6. Moſt of the earths combine with tan, and form with it compounds which are chiefly inſoluble in water. Lime water, added to the infuſion of galls, produces an olive-coloured precipitate. A ſimilar precipitate is obtained by means of barytes, ſtrontites, and magneſia.

2510 Metallic oxides and ſalts.

7. The metallic oxides combine with tan, and form compounds which are nearly inſoluble in water. Similar precipitates are obtained by means of many of the metallic ſalts. The green ſulphate of iron produces no precipitate; but the red ſulphate gives a deep-blue precipitate, which becomes black by expoſure to the air, or when it is dried. This is the baſe of writing ink, as was formerly deſcribed in treating of the ſulphate of iron.

2511 Gelatine.

8. Tan forms an inſoluble compound with gelatine, which is the principle of the important proceſs of tanning leather, and is nothing more than the combination of tan with the animal matter called *gelatine* or *glue*.

2512 Exiſts in the bark chiefly.

9. Tan is chiefly found in the bark of trees; it is alſo found in the leaves, the wood, the ſap, and ſometimes it is obtained by ſpontaneous exudation, as is the caſe with the ſubſtance called *kino*. Several varieties of tan have been found in different vegetable ſubſtances, as in catechu, dragon's blood, ſumach, and fuſtic.

2513 Proportion varies.

10. The quantity of tan varies with the age and ſize of the tree, and at different ſeaſons. The greateſt proportion has been found in the inner bark. Mr Davy aſcertained the quantity of tan obtained from the ſolid matter extracted by water, from an ounce of different vegetable ſubſtances.

	Solid Matter.	Tan.
White inner bark of old oak	108 grs.	72 grs.
young oak	111	77
Spaniſh cheſnut	89	63
Leiceſter willow	117	79
Coloured or middle bark of oak	43	19
Spaniſh cheſnut	41	14
Leiceſter willow	34	16
Entire bark of oak	61	29
Spaniſh cheſnut	53	21
Leiceſter willow	71	33
elm	—	13
common willow	—	11
Sicilian ſumach	165	78
Malaga ſumach	156	79
Souchong tea	—	48
Green tea	—	41
Bombay catechu	—	261
Bengal catechu	—	231
Nut-galls	180	127 *

2514 Proportions in different plants.

The following proportions of tan were found by adding a ſolution of glue to the infuſion of the plant in water.

	Proportion of Tan.		Proportion of Tan.
Elm	2.1	Sallow	4.6
Oak cut in winter	2.1	Mountain aſh	4.7
Horſe cheſnut	2.2	Poplar	6.0
Beech	2.4	Hazel	6.3
Willow boughs	2.4	Aſh	6.6
Elder	3.0	Spaniſh cheſnut	9.0
Plum tree	4.0	Smooth oak	9.2
Willow trunk	4.0	Oak cut in ſpring	9.6
Sycamore	4.1	Leiceſter willow	10.1
Birch	4.1	Sumach	16.2*
Cherry tree	4.2		

XX. Of Suber.

2515 Conſtitutes the epidermis.

1. The vegetable ſubſtance denoted by the name of *ſuber*, is, according to Fourcroy, the epidermis or outer covering of trees. This ſubſtance is analogous to common cork, which is the epidermis of the *quercus ſuber*, from which the name of this peculiar vegetable ſubſtance is derived.

2516 Properties.

2. It is a light, ſoft, elaſtic ſubſtance, is inſoluble in water, but readily abſorbs this liquid. Common cork is the ſame ſubſtance, having greater denſity, and accumulated in greater quantity.

2517 Action of heat.

3. This matter is very combuſtible, and burns with a white vivid flame, leaving behind a very black, light, voluminous coaly matter. When this matter is diſtilled, it yields ammonia.

2518 Of nitric acid.

4. When cork is treated with nitric acid, carbonic acid gas and nitrous gas are evolved. The cork is decompoſed, and converted, partly into a yellow, ſoft, unctuous matter, which ſwims on the ſurface, and partly into ſuberic acid; the nature and properties of which have been already deſcribed.

XXI. Of Alkalies.

2519 Fixed alkalies only found.

1. The fixed alkalies only have been detected in plants, and there are few plants which do not yield a ſmaller or greater proportion of one of theſe alkalies. It is ſuppoſed that they exiſt in plants, in combination with acetic and carbonic acids.

2520 Potaſh.

2. Potaſh, formerly called *vegetable alkali*, becauſe it was ſuppoſed to exiſt only in vegetables, is found in all plants except thoſe which grow near the ſea. The proceſs for extracting it has been already deſcribed. The vegetables are reduced to aſhes by burning; the aſhes waſhed with water, which is filtered and evaporated to dryneſs. The potaſh remains behind.

3. Shrubby and herbaceous plants yield a greater proportion of aſhes than trees. The branches of trees afford more aſhes than the trunk, and the leaves yield more than the branches. Other ſalts are found mixed with the potaſh, ſuch as the ſulphates of potaſh and of lime, muriate of potaſh, phoſphate of lime, and phoſphate of potaſh; the latter of which has been detected in maize and wheat. In the following table the proportion of aſhes obtained from 100 parts of different plants, and the quantity of potaſh which theſe aſhes yield, are exhibited.

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* *Phil. Tranſ.* 1803.

* *Phil. Tranſ.* 1799.

Component Parts of Vegetables.

	Aſhes	Potaſh
Sallow,	2.8	0.285
Elm,	2.36727	39.——
Oak,	1.351185	0.15343
Poplar,	1.23476	0.07481
Hornbeam,	1.1283	0.1254
Beech,	0.58432	0.14572
Fir,	0.34133	0.00000
Vine branches,	3.397	0.55
Common nettle,	10.67186	2.5033
Common thiſtle,	4.04265	0.53734
Fern,	5.00781	0.6259
Cow thiſtle,	10.5	1.96603
Great river ruſh,	3.85395	0.72234
Feathered ruſh,	4.33593	0.50811
Stems of Turkey wheat,	8.86	1.75
Wormwood,	9.744	7.3
Fumitory,	21.9	7.9
Red clover,		0.078
Vetches,		2.75
Beans with their ſtalks,		2.

2521 Soda. 4. Soda is generally found in all marine plants, and in many others which grow near the ſhore. The proportion of ſoda which many plants containing it yield, is very conſiderable. A hundred parts of the *ſalſola ſoda* afford 19.921 of aſhes, from which may be extracted 1.992 part of ſoda. It is from different ſpecies of *fuci* that the ſoda or kelp of Britain is obtained. The ſoda of commerce is extracted from two ſpecies of ſalſola, namely the *ſativa* and *vermiculata*, which grow abundantly on the ſhores of Spain and the Mediterranean.

XXII. Of Earths.

2522 Lime. 1. Four of the earths have been detected in vegetables, namely lime, ſilica, magneſia, and alumina. Few plants have been found which do not contain ſome portion of lime. It is the moſt abundant of all the earths in plants.

2523 Silica. 2. Silica has been found in ſeveral plants, and chiefly in the epidermis, ſome of which are almoſt entirely compoſed of this earth. A hundred parts of the epidermis of the following plants yielded the annexed proportions of this earth.

Bonnet cane,	90
Bamboo,	71.4
Common reed,	48.1
Stalk of corn,	6.5

2524 Magneſia. 3. Magneſia is more rarely found in vegetables. It has been detected in conſiderable proportion in the fuci and other ſea plants. The greateſt proportion yet diſcovered is found in the ſalſola ſoda. A hundred parts of this plant have yielded 17.929 of magneſia.

2525 Alumina. 4. Alumina is found in plants in very ſmall quantity.

2526 Proportion of earths. 5. In the following table are exhibited the quantity of earths in general, found in 100 parts of different plants.

Oak,	1.03
Beech,	1.453
Fir,	0.003
Turkey wheat,	7.11
Sun-flower,	3.72
Vine branches,	2.85
Box,	2.674
Willow,	2.515
Elm,	1.96
Aſpen	1.146
Fern,	3.221
Wormwood,	2.444
Fumitory,	14.000

Component Parts of Vegetables.

Herbaceous plants, it appears, contain a greater proportion of earths than trees. In all the kinds of grain which Bergman examined, he found all the four earths. From 100 parts of oat grain, Vauquelin obtained a reſiduum of 3.1591, which by analyſis he found to be compoſed of

Silica,	60.7
Phoſphate of lime,	39.3
	100.0

By burning the ſtem and ſeeds of the ſame grain, the reſiduum by analyſis afforded the following ſubſtances.

Silica,	55
Phoſphate of lime,	15
Potaſh,	20
Carbonate of lime,	5
	95

Some traces of oxide of iron were alſo detected.

XXIII. Of Metals.

The only metallic ſubſtances which have certainly been found in plants are iron and mangameſe. Iron has been detected in the aſhes of ſalſola; and manganeſe has been found in the aſhes of the pine, green oak, calendula, vine, and fig-tree. Gold, it is ſaid, has been found in ſome plants, but in very minute proportion. 2527 Iron and mangameſe.

Chap. XIX. Of ANIMALS.

Animals conſtitute the ſecond diviſion of organized matter. They are diſtinguiſhed from vegetables by texture, form, and component parts. The more characteriſtic differences between animals and vegetables are, the locomotive power of animals, irritability, and ſenſibility. Animal matters paſs to the putrid fermentation, and they are all ſoluble in the alkalies. Sulphuric acid reduces animal ſubſtances to a carbonaceous matter. Charcoal is precipitated, and ammonia is diſengaged. Nitric acid acts violently on animal ſubſtances, with the evolution of azotic gas. 2528 Character.

In treating of animal matters, we ſhall firſt conſider the functions of living animals; 2. Their decompoſition; and, 3. Their component parts. Theſe ſubjects ſhall occupy the three following ſections.

Sect. I. *Of the Functions of Animals.*

In taking a view of animal ſubſtances, it is neceſſary to conſider the function of the living animal, ſo far 2529 Cannot be explained on chemical principles.

far at leaſt as theſe functions admit of explanation on chemical principles. It is beyond the reach of human ſagacity fully to underſtand the ſimpleſt proceſſes in the animal economy. Theſe cannot be explained on chemical or mechanical principles; but to comprehend clearly and fully, even what is known of the functions of living animals, it would be neceſſary to enter into a deſcription of the ſtructure and nature of the organs which are employed in theſe functions. But this is not the province of chemiſtry; it belongs to the ſciences of ANATOMY and PHYSIOLOGY. We muſt therefore content ourſelves with giving a ſhort account of the chemical changes which take place by the action of living animals. The functions of animals which have occupied the attention of chemical phyſiologiſts, and which we propoſe to treat of in this ſection, are reſpiration, digeſtion, ſecretion, and aſſimilation.

I. Of Reſpiration.

2530
A vital function.

1. Reſpiration is to be conſidered as one of the vital functions of animals. No animal can exiſt when it is interrupted, nor indeed can it be ſuſpended, even for the ſhorteſt time, without the hazard of life. In the mechanical part of the function of reſpiration, the air is alternately drawn into the lungs and expelled.

2531
All gaſes not fit for reſpiration.

2. It is well known that all gaſes are not fit for reſpiration. Some indeed, as carbonic acid gas, the moment they are inhaled, are deſtructive to life. The reſpiration of others, although they are not productive of ſuch ſudden effects, yet at laſt they prove fatal to the animal which is forced to reſpire them. Animals are very differently conſtituted, both with regard to the ſtructure of their reſpiratory organs, and with regard to the quantity of air which muſt be reſpired in order to ſupport life. In theſe reſpects, the hot and cold-blooded animals are very different from each other; and even among the latter claſs, namely the cold-blooded animals, there are ſome tribes which require a very ſmall quantity of air, and can bear without much ſeeming inconvenience a temporary interruption of this function; but for all animals, whatever be their nature, whatever be their ſtructure, or whatever be the modifications of their reſpiratory ſyſtem, the air of the atmoſphere is the moſt proper for the ſupport of life. It is the oxygen of atmoſpheric air which is neceſſary for the breathing of animals; but although animals live longer in a given quantity of oxygen gas than in atmoſpheric air, as appears from the experiments of Count Morozzo, related in the chapter on oxygen gas, yet it is too powerful, or too ſtimulating for their organs; for to ſuch as have been confined to breathe it, it has been found highly injurious.

2532
Not even pure oxygen.

2533
Some fatal to life.

3. Some of the gaſes prove immediately fatal to life; ſuch for inſtance is carbonic acid gas. It ſeems to be certain that no animal ever made a full inſpiration of this gas, without being deſtroyed. Nay, it is ſo noxious to animal life, that the organs themſelves, by an involuntary action, obſtruct it in its paſſage to the lungs. Other gaſes are equally fatal after a few inſpirations, ſuch as hydrogen and azotic gaſes; and indeed it is probable, if the lungs were completely emptied of air, before the inſpiration of any gas whatever, excepting oxygen gas or atmoſpheric air, a ſingle inſpiration would prove fatal. This, however, is never the caſe; for after the fulleſt expiration, a conſiderable quantity of air remains in the lungs. We may conclude, therefore, that the air of the atmoſphere alone is proper for the reſpiration of animals, and the ſupport of life.

2534
The ſame air can only be once reſpired.

4. After the ſame quantity of atmoſpheric air or oxygen gas has been once reſpired by animals, it becomes totally unfit for farther reſpiration either by the ſame animals or any other. It is then not only deprived of the whole of the oxygen, but is alſo contaminated with noxious gaſes. This even happens to fiſhes and inſects which require a very ſmall quantity of air. If the water in which the former live be deprived of its air, it is equally fatal to them as being immerſed under water is to thoſe animals which live in the air of the atmoſphere.

2535
The quantity.

5. Attempts have been made by phyſiologiſts to aſcertain the quantity of air reſpired by animals. This, it will appear at firſt ſight, muſt be extremely different in different claſſes of animals. Even in the ſame claſs of animals, it is probable that it varies much. The difference of the reſults of experiments on man to aſcertain this point are enormous. No concluſion whatever can be drawn from the number of reſpirations made in a given time, even if this could be determined with any degree of accuracy, which is ſcarcely to be expected. For no function of the body is ſooner influenced by mental affections than the breathing. The very attention to the circumſtance of reckoning the number of reſpirations will have ſome effect in occaſioning conſiderable deviatons from the natural number. The number of reſpirations which have been reckoned by ſome is 14 in a minute, while others make the number amount to 27, which ſhews that little dependence can be placed on this mode of calculating the quantity of the air reſpired in a given time. But even if this could be accurately aſcertained, ſtill it would not enable us to aſcertain the quantity of air reſpired. For it is extremely probable that this quantity varies greatly in different men and in different animals, and in the ſame animal at different times, ariſing from cauſes the effects of which either entirely elude obſervation, or are altogether inappreciable. And accordingly we find that the differences of the reſults of the quantity of air taken in at a ſingle inſpiration, or of the quantity calculated in the lungs after expiration, are not leſs than thoſe of the number of reſpirations.

2536
Changes on the air.

6. The nature of the changes which the air inſpired undergoes has been aſcertained with more accuracy, although the experiments made to determine the amount of theſe changes vary conſiderably. Part of the air which is reſpired diſappears; and it has been generally ſuppoſed that it is only the oxygen gas which is taken up. But according to the experiments of Mr Davy, part of the azotic gas alſo diſappears and is abſorbed along with the oxygen. Dr Menzies eſtimates the quantity of oxygen gas abſorbed by a man in 24 hours at rather more than 41 oz. troy. Lavoiſier fixes the quantity conſumed by a man in the ſame time at 32½ oz. nearly; and Mr Davy gives as the reſult of

his experiments and calculations about 33½ oz. of oxygen gas, and 4½ of azotic gas, amounting together to about 38 oz.

2537 Gaſes expired.

7. The air thrown out of the lungs by expiration contains a quantity of carbonic acid gas. But here the reſults of experiments to determine the quantity are as widely different as in other points relating to reſpiration. By one it is reckoned at 15 oz. in 24 hours; by another at not leſs than 37 oz.

2538 Water.

8. Water in the ſtate of vapour is alſo thrown out of the lungs during reſpiration. The quantity eſtimated by different philoſophers exhibits the ſame difference of reſults as in the other ſubſtances. According to Hales it is 20½ oz. nearly; according to Lavoiſier it amounts to 28½ oz.

2539 Component parts of the air expired.

9. But although it ſeems difficult or perhaps impoſſible to aſcertain with perfect accuracy the proportions or quantity of each of the ſubſtances thrown out of the lungs, yet it is clearly proved by experiment, that the component parts of the air expired are azotic gas, carbonic acid gas, and water in the ſtate of vapour.

2540 Circulation of the blood.

10. The blood, as it flows from the left ſide of the heart, is of a bright red colour. It is conveyed by the arteries to every part of the body. It is then taken up by the veins, and carried back to the heart, by means of the venous ſyſtem. The blood having thus circulated through the body, enters the right ſide of the heart, and has totally changed its colour. It is now of a dark purpliſh red, inſtead of the bright red colour which it poſſeſſed when it paſſed out of the heart, to be diſtributed through the body. But before the blood can paſs to the left ſide of the heart, again to enter the circulation, it muſt paſs through the lungs, where it again acquires the bright red colour. From the lungs it paſſes to the left ſide of the heart, from which it flows as before through the arterial ſyſtem to all parts of the body. The blood then acquires this florid red colour in the lungs. Let us now ſee in what this change conſiſts.

2541 Changes on the blood.

11. This change was aſcribed by ſome of the earlier chemical phyſiologiſts to the abſorption of air. Dr Prieſtley obſerved that venous blood, which was of a dark colour, became of a bright red when expoſed to oxygen gas, and that hydrogen gas produced a contrary effect. The ſame thing has been aſcertained ſince, by many other chemiſts. According to Dr Prieſtley, the blood was deprived of its phlogiſton as it paſſed through the lungs: but according to the theory of Lavoiſier and others, no part of the air inſpired is abſorbed; the blood gives out hydrogen and carbone, which, combining with the oxygen of the air, form water and carbonic acid. He ſuppoſed that the quantity of oxygen in the water and carbonic acid expired was equal to that which had diſappeared during reſpiration. According to another theory, the oxygen gas combines with the blood, and while this combination takes place, the carbonic acid gas and water which are expelled from the lungs along with the azotic gas, are given out. According to later experiments, it has been aſcertained that not only the whole of the oxygen of atmoſpheric air, but part of the azote, is abſorbed during reſpiration; and indeed ſome have ſuppoſed that the whole of the atmoſpheric air is abſorbed by the blood unaltered, and that it is only after this abſorption that the decompoſition takes place. The whole of the oxygen and part of the azote are retained, and the remaining part of the azote is thrown out, along with the carbonic acid gas and water, which are expired; but this opinion, as well as moſt others with regard to the nature of the changes that take place during reſpiration, reſts in a great meaſure on plauſible conjecture.

2542 Are the ſubſtances expired formed in the blood?

12. A queſtion has ariſen among chemiſts with regard to the formation of the carbonic acid and the water which are expired; whether it takes place immediately in the lungs, by the direct combination of the oxygen of the air with the carbone and hydrogen of the blood, or whether theſe ſubſtances previouſly exiſted in the blood in a ſtate of combination, and are thrown out during reſpiration.

2543 Purpoſes of reſpiration.

13. What are the purpoſes of theſe changes? What are the uſes of reſpiration in the animal economy? As the blood is the ſource from which are derived the materials for repairing the conſtant waſte of the body, it is neceſſary that means ſhould be provided, to ſupply this waſte, to which the blood is conſtantly ſubjected. This is accompliſhed, as we ſhall find afterwards, by the proceſs of digeſtion, the product of which is conveyed to the blood. But before it can be converted into blood, it muſt undergo certain changes, which take place in the lungs. There is one eſſential part of the blood, and an eſſential part alſo of animal bodies, namely the fibrina, which does not exiſt in the chyle and lymph, which are the ſubſtances conveyed to the blood, to repair its waſte, before they have paſſed through the lungs along with the blood. Hence it is ſuppoſed that one purpoſe of reſpiration is to form the fibrina of the blood.

2544 To form fibrina.

2545 To preſerve temperature.

14. But another great purpoſe of reſpiration in the animal economy is to preſerve the proper degree of temperature neceſſary for the health and life of the animal. It is well known that the temperature of animals is not regulated like inorganized matter by the ſurrounding medium. In whatever temperature animals are placed, except in thoſe extreme degrees of heat or cold which deſtroy life altogether, the temperature of their bodies continues almoſt uniformly the ſame, and this temperature, it appears, correſponds to the quantity of air inſpired. Hence it is that the temperature of the lower orders of animals which require but a ſmall proportion of air, as inſects, fiſhes, and amphibious animals, is not much higher than that of the medium in which they live, and on this account they conſtitute a diviſion of animals which have been diſtinguiſhed by phyſiologiſts by the name of *cold-blooded animals*. The temperature of warm-blooded animals, whatever be the temperature in which they live, is from 96° to 104°. The temperature of man is about 98°, while that of birds which require a greater proportional quantity of air, is uſually 5° or 6° higher.

2546 Theories of animal heat.

15. The manner in which the temperature of the body is kept up by means of reſpiration, has been thus accounted for, on the principles of Dr Black's theory of latent heat. Part of the latent heat of the air, which was inſpired and combined with the blood, is given out, and thus raiſes the temperature of the blood and that of the whole body through which it circulates.

lates. But if this change took place in the lungs, and all the latent heat of the air inſpired was extricated in that organ, it was urged as an objection to this theory, that the temperature in them would be much higher than in other parts of the body. According to the theory of Lavoiſier and Crawford, the oxygen gas of the air inſpired combines with the hydrogen and carbone which are given out by the blood, forming carbonic acid and water. During this proceſs, which takes place in the lungs, the latent heat of the oxygen becomes ſenſible. Part of it combines with the water and the carbonic acid, and converts them to the ſtate of gas; the remainder combines with the blood, to preſerve the temperature of the body. The capacity of arterial blood for caloric, or the ſpecific caloric of arterial blood, that is, the quantity of caloric which is neceſſary to raiſe it to a given temperature, is much greater than that of venous blood. According to this theory, therefore, the ſpecific caloric of arterial blood, as it circulates through the body, is more and more diminiſhed, till it is at laſt converted into venous blood. In this way it has been propoſed to obviate the objection of the temperature of the lungs being higheſt, if, as it has been ſuppoſed, the whole of the caloric is here evolved; and to account for the uniformity of temperature which exiſts in every part of the body.

2547 Air abſorbed in the ſtate of gas.

16. But if the difference of the ſpecific caloric of arterial and venous blood be not ſufficiently great to account for the phenomena, this objection has been attempted to be removed, by ſuppoſing that the air is abſorbed by the blood in the ſtate of gas, and that the greateſt part of the changes which it undergoes, is effected in the courſe of the circulation. Part of the caloric, it is ſuppoſed, is evolved, when the air combines with the blood, and this portion combining with the carbonic acid and water thrown off, raiſes them to the ſtate of gas, in which ſtate they are emitted during reſpiration. The air abſorbed by the blood gives out the remaining portion of its caloric in the courſe of the circulation, when the oxygen combines with the carbone and forms carbonic acid, and with the hydrogen and forms water; and thus the caloric is gradually evolved during the courſe of the circulation. Such then are two of the important purpoſes which ſeem to be accompliſhed by means of the function of reſpiration; namely, the preſervation of animal temperature, and the complete formation of the blood.

II. Of Digeſtion.

2548 Waſte of the body.

1. The animal body is ſubject to continual waſte, and the quantity of this waſte varies according to the nature and age of the animal. This waſte is repaired by the blood, which muſt conſequently receive ſome ſupplies, to make up for its continual conſumption. On this account, all animals require food or nouriſhment, to compenſate for the waſte of the body, and directly for the conſumption of the blood from which this waſte is ſupplied.

2549 Food of different animals different.

2. Different animals, according to their nature, conſtitution, and circumſtances in which they are placed, require different kinds of food. Some animals live entirely on vegetables, others feed excluſively on animals, while a third claſs feed indiſcriminately both on vegetables and animals. But whatever be the kind of food, or whatever be the nature of the animal, it is all converted, by the proceſs of digeſtion, into the ſame uniform ſubſtance. In moſt animals the food, as it is taken into the mouth, is broken down, mixed with the ſaliva, and conveyed to the ſtomach, and after it has remained there for a ſhort time, it is totally changed, and is converted into the uniform ſubſtance above alluded to, called *chyme*.

2550 Falſe analogies of phyſiologiſts.

3. In attempting to account for the functions of the animal body, chemiſts and phyſiologiſts have been always too much diſpoſed to conſider the changes which take place within the body, as analogous to thoſe which take place on inorganized or dead matter, in ſuppoſed ſimilar circumſtances. Accordingly we find among the ſpeculations of philoſophers, concerning the nature of the function of digeſtion, that it has been aſcribed to fermentation. By one ſet it was aſcribed to one kind of fermentation, namely to the vinous or acetous; and by another ſet this converſion of the food was ſuppoſed to be effected by the putrefactive fermentation. But now, that the nature and circumſtances of the proceſſes of fermentation and digeſtion have been more accurately obſerved, this opinion, it is probable, is univerſally exploded. The experiments of phyſiologiſts, alſo, have led to more rational views concerning this function.

2551 Gaſtric juice.

4. It is now generally admitted, that the converſion of the food into chyme, is effected by the action of a peculiar fluid ſecreted in the ſtomach, from which it has been denominated *gaſtric juice*. This liquid ſeems to poſſeſs different properties in different animals, for thoſe animals which live entirely on vegetables cannot digeſt animal food, and the gaſtric juice of thoſe which have been accuſtomed to live entirely on animals, has no effect on vegetables. It is true, indeed, that the nature of animals in this reſpect, as well as in moſt of their habits, may be completely reverſed, when it is effected by ſlow degrees. All ſubſtances taken into the ſtomach, are not equally acted upon by the gaſtric juice. Some of the hardeſt are readily diſſolved, while others ſeemingly leſs compact and durable, remain unaltered. The huſks of grain in the ſtomachs of many animals reſiſt its action, while the hardeſt bone is entirely conſumed.

2552 Its nature unknown.

5. No accurate knowledge has yet been obtained concerning the nature of the gaſtric juice. According to ſome it is of an alkaline nature, and according to others it poſſeſſes acid properties. But this difference of opinion is by no means to be wondered at, if we conſider the difficulty, or perhaps the impoſſibility of obtaining the gaſtric juice in a ſtate of purity, to ſubject it to chemical examination. If it even were poſſible to collect it perfectly pure, its effects could not be the ſame as within the body, ſince all animal matters, the moment they are ſeparated from the living body, begin to undergo new changes, and therefore muſt exhibit new properties. All experiments, therefore, which have been made, to aſcertain the nature of the gaſtric juice, and the proceſs of digeſtion out of the body, muſt be conſidered as entirely inconcluſive. Such experiments ſhew us the effects of this liquid in the ſtate of dead matter, but can lead to no knowledge of its na-

ture and properties while it exiſts in the living body (B).

2553 Food converted into chyme. 6. But whatever be the nature of this liquid, or the proceſs of digeſtion, the food, as we have already obſerved, is broken down in the mouth and mixed with the ſaliva, which in the firſt inſtance, probably contributes much to favour its commencement; for it has been obſerved that the proceſs of digeſtion is conſiderably deranged when the ſecretion of ſaliva is interrupted, or its uſual quantity diminiſhed. All, then, that is certainly known concerning this change is, that the food conveyed to the ſtomach is in a very ſhort time converted into the ſubſtance called chyme.

2554 Which is changed into chyle. 7. The chyme, which is a ſoft, pulpy matter, after being formed in the ſtomach, is carried to the inteſtines, where it is mixed with other ſubſtances, and undergoes new changes. As ſoon as the chyme has paſſed into the inteſtines, it is converted partly into a milky fluid called chyle, and partly into excrementitious matter. Thus it is decompoſed by ſome proceſs, and ſeparated into two parts, one of which is deſtined for the nouriſhment of the body, and for repairing its waſte, while the other is ejected.

2555 Chyle ſeparates into two parts. 8. The chyle, ſoon after it is formed from the chyme, mixes with the bile which flows from the liver into the inteſtines. In conſequence of this combination, it is ſuppoſed the excrementitious matter is ſeparated from the chyle, and is thrown out of the body; while the chyle itſelf is taken up by a ſet of veſſels called *lacteals*, which open on the inner ſurface of the inteſtines, and receiving the fluid, convey it to a large trunk in which they all terminate, denominated, from its ſituation in the thorax, the *thoracic duct*. The uſe of the bile is ſuppoſed to be, to ſeparate the excrementitious matter which might prove injurious to the ſyſtem, if it were abſorbed along with the chyle; and for this purpoſe the bile, it is ſuppoſed, is decompoſed; one part, namely its ſaline and alkaline conſtituents, combines with the chyle, by which it becomes more liquid, while another part, namely the reſinous and albuminous matter, combines with the excrement, and in this ſtate acts as a ſtimulant to the inteſtines, ſo that the contents which might otherwiſe prove injurious, if long retained, are ejected.

2556 Is totally changed. 9. As a proof that the food which has been taken into the body has been totally changed, ſubſtances have been detected in the excrement of different animals which did not previouſly exiſt in the food. According to Vauquelin, excrementitious matter is always diſtinguiſhed by an acid property. Benzoic acid has been detected in that of horſes and cows. An acid of a peculiar nature has been found in the dung of pigeons; but in general this matter is much diſpoſed to ferment, and at laſt gives out ammonia.

In the analyſis of the excrement of a hen by Vauquelin, compared with the nouriſhment, he found that the oats which were taken in were compoſed of phoſphate of lime and ſilica, and that the ſhells of the eggs, and the excrements which were examined, conſiſted of phoſphate of lime, carbonate of lime, and ſilica. The proportion of ſilica which was found in the excrement was leſs than the quantity taken in; but the quantity of phoſphate of lime was increaſed, and a quantity of carbonate of lime which did not previouſly exiſt in the food, was formed*.

* Ann. de Chim. xxix. 3.

2557 Properties of chyle. 10. The chyle, it has been obſerved, is taken up by the lacteals and conveyed to the thoracic duct. Little is known of its properties, excepting that it poſſeſſes ſome in common with milk. Like milk, it coagulates, and divides into a ſerous and oily matter. In the thoracic duct the chyle is mixed with another fluid called the lymph, which is conveyed from all parts of the body by a ſet of veſſels which have been denominated *lymphatics*. 2558 Of lymph. This fluid is in conſiderable quantity, is viſcid and colourleſs, but from the difficulty of collecting it, little is known of its properties. The lymph and the chyle, thus mixed together, are conveyed by the thoracic duct to the blood veſſels. It is mixed with the blood in the veins, and conveyed by them to the right ſide of the heart, from which it is carried to the lungs, where it undergoes the changes already deſcribed in the account of reſpiration, and the whole is converted into arterial blood, which returns to the heart, from whence it is diſtributed to all parts of the body.

III. Of Secretion.

2559 Matters ſeparated from the blood. 1. In the courſe of the circulation of the blood, different ſubſtances are ſeparated from it, ſome of which are deſtined for the growth and nouriſhment of the body, as in young animals, or for the repair and ſupply of parts that are deſtroyed; while other ſubſtances, which ſeem either to be ſuperfluous, or if retained, would be injurious, are thrown out of the body. Theſe ſecretions are performed by peculiar organs, the deſcription and operation of which belong to ANATOMY and PHYSIOLOGY. At preſent we ſhall give a ſhort account of two of the moſt important of theſe ſecretions, namely, the ſecretion of urine, and that of perſpirable matter.

2560 By the kidnies. *Secretion of urine.*—The urine, which is an excrementitious matter, is ſeparated from the blood by the action of the kidneys. According to the obſervations of anatomiſts and phyſiologiſts on the ſtructure and office of theſe organs, a great proportion, or even, as ſome ſuppoſe, the whole, of the blood paſſes through them. As the urine ſecreted by theſe organs, ſeems to ſerve no purpoſe in the animal economy, ſince the whole of it is thrown out, it is probable that the ſubſtances of which it is compoſed, or at leaſt their conſtituents, would have proved injurious if they had been retained.

2561 Is an important change. 2. Whatever the change be which takes place on the blood by the action of the kidneys, it is of the utmoſt importance to the health and even to the life of the

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(B) The ſtomach of young animals contains ſome ſubſtance which has the property of coagulating milk. Acids alſo have this property, from which it has been concluded that the ſubſtance in the ſtomach of young animals, which produces this effect on milk, is of an acid nature: but it ought to be recollected, that it is out of the body, and that it has undoubtedly undergone new changes; and beſides, it is not known exactly what ſubſtances may have the property of inducing this change on milk.

the animal; for if theſe organs are deſtroyed by diſeaſe or accident, the death of the animal is the certain conſequence.

3. By the action of the kidneys on the blood, new ſubſtances make their appearance. Such, for inſtance, are urea and uric acid, which exiſt in the urine, but cannot be detected in the blood; but the baſes or conſtituents of theſe ſubſtances muſt have formed part of ſome of the matters of the blood, which are therefore decompoſed for their evolution; and this decompoſition muſt take place in theſe organs. But although the urine, the ſecreted matter, has been accurately analyzed, and its component parts, after it is thrown out of the body, pretty well aſcertained, it is yet unknown what are the peculiar changes which the blood undergoes by the action of the kidneys.

2562 Secretion from the ſkin. *Perſpiration.*—1. A conſiderable quantity of matter is ſeparated from the blood by means of a ſet of veſſels on the ſkin of animals. This action is called *perſpiration*, and the ſubſtance emitted, *perſpirable matter*. The attention of phyſiologiſts and chemiſts has been long directed to aſcertain the quantity and nature of the matter thus thrown off. To aſcertain the firſt point, many experiments have been made. Sanctorius, an Italian phyſician, was the firſt who made this attempt, by weighing himſelf, and eſtimating the quantity of food which was taken in, and the quantity of excrementitious matter thrown off. The difference, he ſuppoſed, indicated the quantity of matter perſpired; but neither in his experiments, nor in thoſe of many others, who endeavoured to aſcertain the ſame thing, was any eſtimate made of the quantity of matter given out by the lungs.

2563 Quantity. 2. With this diſtinction in view, a ſet of experiments was inſtituted by Lavoiſier and Seguin. The latter was incloſed in a varniſhed bag, which prevented the eſcape of every thing thrown off from the body, excepting what was loſt by reſpiration. Having previouſly weighed himſelf, and having continued the experiment for ſome time, the quantity of matter thrown off by reſpiration was aſcertained, by weighing a ſecond time. By weighing himſelf afterwards without the covering, and repeating the operation at the end of a ſimilar interval, he was thus enabled to aſcertain the quantity loſt by tranſpiration from the ſkin, by ſubtracting what had been previouſly aſcertained by tranſpiration from the lungs, from the whole diminution of weight which was indicated in the laſt experiment. From theſe experiments, the following concluſions were drawn.

a. In a ſtate of health, and when there is no diſpoſition to corpulence, the body returns to the ſame weight once every 24 hours.

b. Indigeſtion retards tranſpiration. The weight is increaſed for four days, and on the fifth the body returns to its original weight.

c. Drink only, and not ſolid food, increaſes the perſpiration. It is leaſt at the moment of taking food, and immediately after.

d. The perſpiration is greateſt during digeſtion.

e. The greateſt quantity of matter perſpired amounted in a minute to 26.25 grains troy; the leaſt to nine grains.

f. The pulmonary tranſpiration is proportionally greater than that of the ſkin. It is greater in winter, on account of the neceſſity of preſerving the temperature of the body.

3. The quantity of matter perſpired is greateſt during hot weather, and in hot climates. The quantity too bears a relation to the quantity of urine. The following are the reſults of the experiments of Rye made in Ireland, on the relative proportion of urine and perſpirable matter, which were excreted in the courſe of one day at different ſeaſons of the year.

	Matter perſpired.	*Urine.*
	Ounces.	Ounces.
Winter,	53	42
Spring,	60	40
Summer,	63	37
Autumn,	50	37

2564 Sweat. 4. When the temperature to which the body is expoſed is much elevated, the quantity of perſpired matter is greatly increaſed, and it then appears in a viſible liquid form called *ſweat*. This anſwers a very important purpoſe in the animal economy, for by this means the equilibrium of temperature is preſerved. The heat which is abſorbed is carried off along with the matter which evaporates from the ſurface of the body, and thus the increaſe of temperature which would otherwiſe prove fatal, is prevented.

2565 Component parts. 5. The next object of chemical phyſiologiſts was to aſcertain the nature of the ſubſtance which is perſpired. This has been found extremely difficult, on account of the ſmall quantity which it has been poſſible to collect. But it has been aſcertained that it conſiſts chiefly of water and carbone, with an oily matter. Phoſphoric acid alſo, and phoſphate of lime, have been detected in the perſpirable matter. In the air which has been confined in contact with the ſkin, carbonic acid gas has been detected; from which it is concluded, that either the carbone muſt have been evolved, and combined with the oygen of the air, or the oxygen gas muſt have been abſorbed, and combining with the carbone, is given out in the ſtate of carbonic acid. The oily matter which is emitted by the ſkin, is ſuppoſed to occaſion the peculiar ſmell by which animals are diſtinguiſhed. The remarkable circumſtance of a dog being able to trace another animal to a great diſtance by the ſmell, or to diſcover his maſter by the ſame means to a much greater diſtance, is aſcribed to the emiſſion of this matter. The matter perſpired, according to Berthollet, poſſeſſes acid properties, and the acid he ſuppoſes, is the phoſphoric. Phoſphate of lime has been detected in the ſkins of horſes by Fourcroy and Vauquelin.

2566 Other ſecretions. Beſides theſe, there are other ſecretions which are deſtined for peculiar purpoſes in the animal economy, or immediately connected with the functions of particular organs, or parts of the ſyſtem. Such is the ſecretion of ſaliva in the mouth, of tears in the eyes, of mucus in the noſe, and wax in the ears. The ſecretion of milk in the female is deſtined for the nouriſhment of the offspring; but we ſhall not enter into the deſcription of the organs employed in theſe ſecretions. The nature and properties of the matters ſecreted will come under our conſideration in treating of the different parts of animals.

IV. Of Aſſimilation.

2567 Waſte of the body muſt be repaired.

1. The continual waſte and decay of the body require to be repaired. This, as we have already ſeen, is the purpoſe of taking nouriſhment into the body; part of which being ſubject to the proceſſes of digeſtion and reſpiration, is converted into blood, from which ſource are derived thoſe ſupplies of new matter which are wanted in the formation of new parts, or to make up the general decay of the ſyſtem. New ſupplies of matter are peculiarly neceſſary, in young animals, in which the parts already formed increaſe in ſize and conſiſtency, and in which, in the progreſs of the growth of the body, entirely new parts are evolved. But if there be any thing in the ſpeculations of phyſiologiſts, of the whole matter in the body being periodically changed, even after it has arrived at its full growth, a conſtant ſupply of new matter becomes abſolutely neceſſary. All theſe ſupplies are furniſhed by the blood, and for this purpoſe it is diſtributed to every part of the body. The materials for repairing the general waſte, for increaſing thoſe parts which are already formed, or for the formation of new parts, are all derived from it. From this ſource are derived the moſt fluid, as well as the moſt ſolid parts of the body; the ſaliva of the mouth, and the gaſtric juice of the ſtomach, ſo neceſſary in the function of digeſtion, by which the health and life of the animal are preſerved, as well as the bones and muſcles, which give it ſtrength, firmneſs and motion. The proceſs by which the different ſubſtances which are furniſhed by the blood for the repair of ſome parts and the formation of others, has been diſtinguiſhed by the name of *aſſimilation*, becauſe, in conſequence of new actions and combinations, matter exactly ſimilar to the parts repaired or renewed, is depoſited, which did not previouſly exiſt in the blood.

2568 By particular organs.

2. Theſe changes are effected by the action of peculiar organs or veſſels. Whatever be the nature of the food taken into the ſtomach, it is converted into chyme by the proceſs of digeſtion. This again, by a farther change, as it paſſes into the inteſtines, forms the chyle, which is conveyed to the blood, and after this fluid has undergone the changes which are induced on it by reſpiration, it has acquired thoſe properties which render it fit for the important purpoſes to which it is deſtined.

2569 Which always ſecrete the ſame matter.

3. By the action of the different ſecretory organs, the ſame matter is always ſeparated from the blood, while the animal continues in the healthy ſtate. The perſpirable matter is ſeparated by the glands or veſſels on the ſkin, and the ſaliva is prepared by the glands of the mouth. The matter of bones, of muſcles, or of nerves, is ſeparated and depoſited in thoſe places where it is required, and no other. In the healthy ſtate of the body, muſcular matter is not depoſited among the bones, nor is oſſeous matter mixed with the muſcles.

2570 Functions vary with circumſtances.

4. The moſt aſtoniſhing part of the animal ſyſtem is that power which it poſſeſſes of accommodating itſelf to particular circumſtances. It would be leſs ſurpriſing that the ſame actions and the ſame functions, after they have commenced, ſhould continue to be performed with uniformity and regularity. But, in the animal ſyſtem, new actions take place, or at leaſt thoſe which were comparatively feeble and limited, become more powerful and more extenſive. Thus, a part of the body which has been deſtroyed or removed, is by this new or extended action, completely renovated. A large piece of muſcle in the healthy ſtate of the body is ſoon renewed; and, what is more ſurpriſing, the conſtituent parts of bone are prepared, when neceſſary, and depoſited in thoſe places where large pieces of this ſubſtance have been removed.

2571 Are regulated by the living principle.

5. But although ſome, or perhaps all theſe changes which take place in the different proceſſes going on in the animal ſyſtem, are of a chemical nature, yet they are ſubject to the controul of ſome power, the characteriſtics of which are totally different from thoſe of a chemical or mechanical agent. This is the living principle which counteracts, regulates, and directs the effects of chemical agents. It is by means of this power, that the materials of which the different parts of the body are compoſed, are depoſited in their proper places. It is by means of the ſame power that a greater quantity of matter neceſſary for the renovation of any particular part which has been deſtroyed, is prepared and depoſited exactly in that place where it is wanted; but the power of this agent is limited. Certain ſubſtances taken into the ſtomach, which are unfit for digeſtion or nouriſhment, are immediately rejected; but others are too powerful, and deſtroy the organ itſelf. As the ſtrongeſt proof of the exiſtence and controul of this power, the conſtituent parts of animal bodies begin immediately to decompoſe each other as ſoon as its action has ceaſed. The gaſtric juice of the ſtomach, which acts only on the ſubſtances introduced into it in the living ſtate, has been ſometimes found to corrode and deſtroy the ſtomach itſelf, after death. But the inveſtigation of the nature of this agent, and of its influence on the animal body, belonging to PHYSIOLOGY.

SECT. II. *Of the* DECOMPOSITION *of* ANIMAL SUBSTANCES.

2572 Decompoſition of vegetables and animals different.

1. As ſoon as an animal has ceaſed to live, its frame and texture are deſtroyed, the conſtituent parts are ſeparated, they enter into new combinations, new ſubſtances are formed, and the component parts are totally changed. The rapid ſpontaneous decompoſition of animal matters, which has been called *putrefaction*, is one of the moſt ſtriking characters by which they are diſtinguiſhed. Vegetable matters, we have ſeen, when vegetation ceaſes, are alſo ſubject to decompoſition; but in them the proceſs is ſlow and gradual, and many of the products are totally different.

2573 Owing to the difference of compoſition.

2. The remarkable difference between the ſpontaneous decompoſition of vegetables and animals, depends on the difference of the conſtituent parts of theſe two claſſes of organized ſubſtances. Animal matters are compoſed of a greater variety of conſtituent principles, and thus originates a greater variety of action, when the different component parts begin to act on each other. By the numerous and complicated attractions which exiſt among theſe conſtituent principles, decompoſition is more readily effected, and a greater variety of new products make their appearance.

2574 Conditions of putrefaction.

3. But notwithſtanding the variety and complicated ſtructure of animal ſubſtances, total decompoſition or

putrefaction does not take place, except in certain circumſtances, by which the mutual action of the conſtituent principles is promoted. The chief circumſtances neceſſary for the putrefaction of animal matter are, moiſture and moderate heat. Dry animal matters do not undergo any change. Bones, when moiſtened with water, the ſoft parts of animals, but eſpecially the liquid parts, run rapidly on to putrefaction. Heat is alſo neceſſary to promote this change. No putrefaction takes place in animal matters, at or below the freezing temperature. Before it commences, the temperature muſt be elevated ſome degrees above this point, and as the temperature riſes, the rapidity of the proceſs is proportional. This condition, however, has its limits; for when the heat reaches a certain point, ſo far from promoting the proceſs of putrefaction, it is retarded, or altogether interrupted, by carrying off the moiſture. The contact of air was thought neceſſary to favour this proceſs; but although it appears that this is not an eſſential condition, putrefaction goes on more rapidly in the open air, perhaps by receiving and carrying off the elaſtic fluids as they are formed. Matters which have already undergone this change, brought in contact with recent animal ſubſtances, promote and accelerate putrefaction.

2575 Phenomena. 4. When animal matters are placed in favourable circumſtances, the ſolid parts become ſoft, and the liquid parts become more fluid. The colour changes, and is converted into a reddiſh brown, or deep green. The odour, which is at firſt diſagreeable, becomes fetid and inſupportable. An ammoniacal ſmell is alſo diffuſed, but this is only temporary, while the putrid odour continues during the whole proceſs. The liquids become turbid, the ſoft parts are melted into a kind of jelly, accompanied with an inteſtine motion, and an enlargement of the bulk of the whole maſs, owing to the eſcape of elaſtic fluids, which are ſlowly diſengaged. The whole matter is then reduced to one maſs, the ſwelling ceaſes, the bulk is diminiſhed, and the colour deepens. Towards the end of the proceſs, a peculiar odour, ſomewhat aromatic, is emitted. When it ceaſes entirely, there remains behind an unctuous, viſcid, and fetid earthy maſs.

2576 The period different. 5. The duration of this proceſs is extremely various, according to the nature of the ſubſtances and the circumſtances in which they are placed; but it has been divided by ſome into different ſtages. In the firſt there is merely a tendency to putrefaction, accompanied with a very ſlight change of texture and colour. The ſecond change, or incipient putrefaction, exhibits ſome traces of acidity; the parts are more ſoftened, a ſerous matter begins to flow from the relaxed fibres; the colour is more altered, and the putrid fetid odour exhaled. In the third or more advanced ſtage of putrefaction, the fetid odour is more or leſs mixed with the ſmell of ammonia; the diſſolved putrid matter becomes of a deeper colour, and is diminiſhed in weight by the eſcape of a great quantity of volatile matter. In the laſt ſtage, or when the proceſs is completed, the ammoniacal odour vaniſhes, the fetid ſmell becomes leſs, and is often ſucceeded by ſomething of an aromatic ſmell. The animal matter has diminiſhed greatly in bulk, and has loſt all appearance of organized ſtructure. There remains only a dark brown, earthy ſubſtance, unctuous to the feel, which has been called *animal earth*. But theſe changes are regulated by the particular circumſtances in which the proceſs takes place.

2577 Elaſtic fluids. 6. In the courſe of the putrefactive proceſs of animal ſubſtances, different gaſes are ſucceſſively emitted. Theſe are chiefly carbonated, ſulphurated, and phoſphorated hydrogen gaſes, water in the ſtate of vapour, ammonia, and carbonic acid gas. Theſe bodies are evolved and volatilized, carrying with them ſome of the principal conſtituents. Other products, formed at different periods of the proceſs, and of a more fixed nature, make their appearance; ſuch, for inſtance, is an unctuous matter, and a kind of ſoap, formed of this matter and ammonia; ſuch too is nitric acid which is frequently formed during this decompoſition, and is combined with an earthy or alkaline baſe; and ſuch finally is the unctuous earth which remains after the evolution and ſeparation of the former products.

2578 Nature of the proceſs. 7. The proceſs of putrefaction, then, conſiſts in a change produced by the action of affinities, more powerful than thoſe which hold together the conſtituent principles of the animal matter. Theſe conſtituents are, hydrogen, azote, carbone, and oxygen, with a certain proportion of ſulphur, phoſphorus, and different ſpecies of phoſphates. During the decompoſition, a portion of the hydrogen combines with azote to form ammonia, while another portion combines with part of the oxygen to form water; part of the carbone is united with a portion of oxygen, and forms carbonic acid; the union of azote with a third portion of oxygen conſtitutes nitric acid; a combination of hydrogen, carbone, and azote, yields a volatile or fixed oil, according to the proportion of the conſtituents; and finally, the ſaline, earthy, and metallic ſubſtances, which are little ſuſceptible of change, during this proceſs, remain unaltered, and conſtitute the reſiduum. Thus, in taking a general view of the affinities which come into action during this proceſs, the amount of thoſe which tend to combine the hydrogen with the azote to form ammonia; the oxygen with the carbone, to form carbonic acid; the carbonic acid with the ammonia, to form carbonate of ammonia; the hydrogen, carbone and oxygen, to form oil, and this latter with ammonia to conſtitute ſoap, beſide the hydrogen and oxygen to form water, is greater than the ſum of the forces which retain in combination, the hydrogen, the azote, the carbone and oxygen, which are the principal conſtituents of animal compounds.

2579 In the open air. 8. Such are the reſults when the proceſs is conducted in cloſe veſſels; but when the proceſs takes place in the open air, ſimilar reſults are obtained, but in a manner ſomewhat different, according to the nature of the compounds which are formed. In this caſe part of the animal ſubſtance is diſſolved and carried off by the air and the water. The ammonia and carbonic acid are diſſipated as they are formed; part of the carbonated hydrogen is alſo volatilized by the increaſe of temperature, and there is no unctuous matter or ammoniacal ſoap formed.

2580 Cauſe of the fetid odour. 9. It is well known that the odour which proceeds from putrid animal matters is extremely offenſive. This is owing in a great meaſure, to the ſulphurated and phoſphorated hydrogen gaſes diſengaged; but it is not merely offenſive, but noxious to the health, and ſometimes deſtructive to the life of animals. Theſe effects are no doubt owing to the putrid effluvia which are exhaled, and which are take into the lungs during reſpiration. To counteract the effects of theſe putrid exhalations, attention ſhould be paid to agitate the air of inhabited places by proper ventilation, which may be done by burning wood in the vicinity of infectious air, ſo that the ſmoke may be mixed with it, or by directing currents of water into ſimilar places. To deſtroy the noxious effects of putrid *miaſmata*, which are produced in confined places, frequented by numbers of people, muriatic acid gas, diſengaged from common ſalt by means of ſulphuric acid, has been ſucceſsfully employed. Oxymuriatic acid gas has alſo been propoſed for the ſame purpoſe.

2581 Method of preſerving animal matters. 10. It is an object of conſiderable importance in domeſtic economy, to prevent the proceſs of putrefaction in thoſe animal ſubſtances which are to be preſerved and employed as food. It is alſo an object of ſome importance for many other purpoſes. Different methods have been propoſed to accompliſh this. It is effected by depriving the animal matters entirely of their moiſture, without which the proceſs is interrupted. Animal matters are alſo preſerved by keeping them at the freezing temperature, or below it. The ſame object is attained by covering up matters to be preſerved with ſuch ſubſtances as readily enter into combination with water, and thus prevent its effects upon the animal matters. The acids, ſugar, alcohol, and ſome ſalts, it is ſuppoſed, act in this way, by preventing putrefaction. With the ſame view aromatic and reſinous ſubſtances, volatile oils, camphor, the powder of dried aſtringent, and fragrant plants, charcoal and bitumen, are employed.

SECT. III. *Of the COMPONENT PARTS of ANIMAL SUBSTANCES.*

Having given a ſhort account of the functions of living animals, and of the ſpontaneous decompoſition which takes place after death, we now proceed to take a view of their component parts, as they have been inveſtigated by chemical analyſis. This ſhall be the ſubject of the preſent ſection, which for the ſake of perſpicuity of arrangement, may be ſubdivided under the four following heads: I. Of the conſtituent parts of animal ſubſtances in general. II. Of the liquid parts of animals. III. Of the ſolid parts; and IV. Of ſubſtances peculiar to different claſſes of animals.

I. Of the Conſtituent Parts of Animal Subſtances in General.

2582 Elements. The ſimple ſubſtances which enter into the compoſition of the different parts of animals, are chiefly azote, carbone, hydrogen, and oxygen, of which, arranged in different proportions, the ſoft parts are compoſed; phoſphorus and lime, which conſtitute the baſis of the hard parts; ſulphur, the fixed alkalies, muriatic acid, iron and manganeſe. But by the conſtituent parts of animals, is here to be underſtood thoſe ſubſtances into which they are reſolved by analyſis. Some of theſe are compound, and ſome are ſimple, as will appear from the following enumeration.

2583 Component parts.

1. Gelatine,
2. Albumen,
3. Fibrina,
4. Urea,
5. Sugar,
6. Oils,
7. Reſins,
8. Phoſphorus,
9. Sulphur,
10. Acids,
11. Alkalies, earths, and metals.

I. Of Gelatine.

2584 Preparation. 1. Glue, a well known ſubſtance in the arts, is gelatine in a ſtate of impurity. This may be obtained pure by repeatedly waſhing the freſh ſkin of an animal in cold water, afterwards boiling it, reducing it to a ſmall quantity by a ſlow evaporation, and allowing it to cool. It then aſſumes the form of a ſolid tremulous ſubſtance called jelly. When this ſubſtance is dried in the air, it becomes hard and ſemitranſparent.

2585 Properties. 2. Gelatine has different degrees of hardneſs, and when pure, it is colourleſs and ſemitranſparent. It is brittle, breaks with a vitreous fracture, and has neither taſte nor ſmell.

2586 Action of heat. 3. When it is expoſed to heat, in the dry ſtate, it becomes white, then blackens, and is converted into a coaly matter. Tremulous gelatine melts before it undergoes theſe changes. When it is diſtilled, it affords a watery fluid, impregnated with ammonia and a fetid oil. A voluminous maſs of charcoal remains behind.

2587 Of air and water. 4. Gelatine remains unaltered in the dry ſtate by expoſure to the air; but the ſolution in water is ſoon decompoſed, giving out an acid, the nature of which is unknown, a fetid odour, and ſome ammonia. It is not very ſoluble in water; it increaſes in bulk, and becomes ſoft and tremulous. In this ſtate it ſoon diſſolves in warm water; but as the ſolution cools, it returns to its former ſtate.

2588 Acids. 5. With the aſſiſtance of heat gelatine is readily diſſolved by the acids. Sulphuric acid acts ſlowly on this ſubſtance, and forms a brown ſolution, which becomes gradually darker with the evolution of ſulphurous acid. Nitric acid by digeſtion on gelatine, is decompoſed; azotic gas is evolved, and afterwards a great quantity of nitrous gas. The gelatine is diſſolved and converted partly into oxalic and malic acids, and an oily matter which remains on the ſurface. Muriatic acid readily diſſolves gelatine, and forms a brown-coloured ſolution, from which a white powder is gradually precipitated. When this ſolution is added to the ſolution of tan in water, a copious precipitate is formed

2589 Alkalies. 6. Gelatine is readily diſſolved by the alkalies, with the aid of heat. There is no action between any of the earths and this ſubſtance.

2590 Metallic oxides. 7. Some of the metallic oxides form precipitates with gelatine in its ſolution in water. The compound thus formed is inſoluble. Similar precipitates are occaſioned by ſome of the metallic ſalts.

2591 Tan. 8. Gelatine forms a copious white precipitate with tan. A brittle compound is thus produced, which is inſoluble in water, and is not changed by expoſure to the air.

2592 Compoſition. 9. The component parts of gelatine are carbone, hydrogen, azote, and oxygen, with ſome traces of phoſphate of lime and of ſoda, but the proportions of theſe ſubſtances have not been determined.

2593 Different kinds. 10. There are various kinds of gelatine, probably ariſing from ſlight variations of the proportions of its conſtituents, or from the addition of other ſubſtances, the nature of which has not been diſtinctly aſcertained. Glue is extracted from different animal ſubſtances, as bones, muſcles, membranes, but eſpecially from ſkins, by firſt ſteeping them in lime-water, to purify them from all extraneous ſubſtances, and afterwards boiling them with pure water. The ſtrongeſt glue is obtained from the ſkins of old animals. What is called *ſize*, is a weaker kind of glue, which is colourleſs and tranſparent, and is extracted from the ſkins of eels, horſes, cats, rabbits, and from ſome kinds of white leather. It is this which is employed in the manufacture of paper, and in gilding and painting. Iſinglaſs, another kind of glue, is extracted from different parts of the ſturgeon, and ſome other fiſh.

2594 Found in different parts of animals. 11. Gelatine forms a principal part, both of the ſolid and fluid parts of animals. It is found in blood and in milk, in the bones, ligaments, ſkin, and other ſolid parts.

2595 Uſes. 12. Animal jelly, which is gelatine, is well known as a very nutritious food, and is much employed in the ſtate of glue, ſize, and iſinglaſs, in numerous arts.

II. Of Albumen.

2596 Obtained from eggs. 1. The white of an egg conſiſts chiefly of albumen. It is combined with a portion of ſoda and ſulphur. From theſe ſubſtances it cannot be ſeparated without decompoſition, ſo that its properties are probably modified by them.

2597 Action of heat. 2. When albumen is expoſed to a heat of about 165° it coagulates into a ſolid white maſs, of different degrees of conſiſtency, according to the duration of the heat applied. This is the characteriſtic property of albumen. In this ſtate it has totally changed its properties. Formerly ſoluble in water, it cannot now be diſſolved in that liquid, either hot or cold.

2598 Cauſe of coagulation. Different opinions have been formed concerning the nature of this change, or the cauſe of the coagulation of albumen. It has been aſcribed by ſome to the abſorption of caloric, and by others to that of oxygen. The former opinion was that of Scheele, and the latter is ſupported by Fourcroy; but this coagulation is found to take place when air is entirely excluded, or without any change being produced in the ſurrounding air. It has been ſuppoſed by others, that the coagulation is produced by the extrication of caloric, as in other caſes when fluid bodies are converted into ſolids. According to an experiment of Fourcroy, this extrication of caloric actually takes place; but it is aſcribed by others to a different arrangement of the particles of the albumen, which is induced by the action of the heat applied.

2599 Propertie of uncoagulated albumen. 3. The properties of albumen, it has been obſerved, are very different after coagulation. Before coagulation it is a glary liquid which has ſcarcely any taſte, and no ſmell. When dried in a moderate heat, it becomes brittle and tranſparent, and by being ſpread thin, forms a varniſh. When thus dried, it is not changed by expoſure to the air, but otherwiſe it ſoon becomes putrid.

2600 Action of heat. 2601 Acids. 4. Albumen is coagulated by means of the acids. With the aid of heat, ſulphuric acid diſſolves it, and forms a ſolution of a green colour. By the action of nitric acid, azotic gas is diſengaged: the albumen is then diſſolved; nitrous gas is given out, and oxalic and malic acids are formed, beſides a thick oily ſubſtance which appears on the ſurface. The coagulation of albumen does not take place when it is diſſolved in a great proportion of water. Albumen is alſo coagulated by means of alcohol and ether, but if the quantity of water in which it is diſſolved be conſiderable, the coagulation is not effected.

2602 Alkalies. 5. By trituration with a concentrated ſolution of pure potaſh, albumen left at reſt for ſome time, coagulates, and is converted into a ſubſtance reſembling jelly, which is brittle and tranſparent when it is dried. No change takes place on albumen by the action of the earths.

2603 Metallic ſalts. 6. Albumen is precipitated, from its ſolution in water, by many metallic ſalts. The precipitate is white, yellow, or brown, according to the metal employed.

2604 Tan. 7. Tan precipitates albumen from its ſolution in water, in the form of a copious yellow ſubſtance, which is inſoluble in water. It becomes brittle when dry, and is not changed by expoſure to the air.

2605 Properties. 2606 Action of heat. *Coagulated albumen.*—Albumen, when it is coagulated, acquires new properties. It is then a tough, opaque ſubſtance, of a pearly-white colour, and of a ſweetiſh taſte. It is inſoluble in water, and is leſs ſubject to change. When it is dried in the temperature of 212°, it is converted into a hard, brittle, yellowiſh ſubſtance, of the tranſparency of horn. When it is ſome time digeſted in water, it becomes ſoft, white, and opaque, like albumen newly coagulated. By long action a ſmall part ſeems to be diſſolved, but no precipitation is formed in this ſolution by the infuſion of tan.

2607 Acids. 8. The mineral acids largely diluted with water, diſſolve a portion of coagulated albumen; but by the addition of the ſame acids in their concentrated ſtate, it is again precipitated. If coagulated albumen be kept in diluted nitric acid for ſeveral weeks, the acid acquires a yellow colour, which gradually deepens; the albumen becomes more opaque, but is not diſſolved. By ſaturating the yellow-coloured acid with ammonia, no precipitate is formed, but it aſſumes a deep orange colour. If the albumen be then introduced into liquid ammonia, the latter aſſumes a deep orange colour, inclining to red. The albumen diſſolves ſlowly, and after the ſolution is completed, it is of a yellowiſh-brown colour. By waſhing and boiling in water, the albumen thus treated with nitric acid, is diſſolved, the liquid becomes of a pale yellow, and aſſumes the form and appearance of jelly, when it is concentrated. If this maſs be diſſolved in boiling water, the ſolution is precipitated by tan; ſo that nitric acid has the property of converting coagulated albumen into gelatine.

2608 Alkalies. 3. Coagulated albumen is readily diſſolved in a ſolution of potaſh by boiling. Ammonia is diſengaged, and a ſoap is formed. If this ſoap be diſſolved in water, and muriatic or acetic acid be added, a precipitate is formed, which alſo has the properties of ſoap. When it is moderately heated, a portion of oil flows out, and a viſcid browniſh ſubſtance remains behind.

2609 Compoſition. 4. Albumen is compoſed of carbone, hydrogen, azote, and oxygen, but the proportions have not been determined. It is ſuppoſed by ſome that it contains a greater proportion of azote than gelatine.

2610 Exiſts in different parts of animals. 5. Albumen conſtitutes an eſſential part in the compoſition of bones and muſcles. Cartilage, horns, and hair conſiſt almoſt entirely of this ſubſtance, as well as the membranous portion of ſhells and ſponge.

2611 Uſes. 6. Albumen is advantageouſly employed for clarifying liquids. The liquid to be purified is mixed with the white of eggs, the ſerous part of the blood, or other ſubſtances containing albumen, and then heated. By the action of heat the albumen is coagulated, and falls to the bottom, carrying with it thoſe ſubſtances which were mixed with the liquid, and occaſioned the opacity, and which, on account of the minuteneſs of the particles, could not be otherwiſe ſeparated.

III. Of Fibrina.

2612 Obtained from blood. 1. Fibrina is readily obtained by allowing blood to remain at reſt for ſome time after it has been drawn from an animal. The clot, which has formed and falls to the bottom, is to be ſeparated, put into a linen cloth, and repeatedly waſhed with water, till the liquid come off inſipid and colourleſs. The fibrous part of the blood, as it has been called, or the fibrina, remains behind. 2613 From muſcle. Mr Hatchet obtained it by cutting lean beef into ſmall pieces, macerating in water for fifteen days, changing the water daily, and ſqueezing it out at the ſame time by preſſure. The muſcular ſubſtance was boiled every day five hours for three weeks in a freſh portion of ſix quarts of water. The fibrous ſubſtance was then preſſed, and dried with the heat of a water bath. What remained is conſidered as fibrina nearly pure.

2614 Properties. 2. Fibrina is of a white colour, ſoft and elaſtic, when it is recently extracted from blood; and, as it dries, the colour becomes deeper. When it is extracted by boiling and maceration from muſcular matter, it is brittle, has ſome degree of tranſparency, and does not become ſo deep in the colour. It has neither taſte nor ſmell. It is inſoluble in water and alcohol, and is not changed by expoſure to the air.

2615 Action of heat. 3. When it is expoſed to heat, it contracts ſuddenly, and emits the ſmell of burning feathers. It melts with an increaſe of temperature. It yields by diſtillation, water, carbonate of ammonia, a thick fetid oil, carbonic acid, and carbonated hydrogen gas, with ſome traces of acetic acid. The coaly matter which remains behind burns with difficulty, on account of the phoſphate of ſoda, phoſphate and carbonate of lime, with which it is mixed.

2616 Acids. 4. Fibrina is ſoluble in the acids. The ſolution in ſulphuric acid is of a deep brown colour; charcoal is precipitated, and acetic acid formed. When diluted nitric acid is added to fibrina, azotic gas is copiouſly diſengaged. Fibrina kept by Mr Hatchett for 15 days in nitric acid diluted with 3 times its weight of water, gave to the ſolution a yellow colour, and it reſembled in its properties the ſolution of albumen in the ſame acid. By this proceſs, after being diſſolved in boiling water, and concentrated by evaporation, the fibrina is converted into gelatine, which is ſoluble in hot water, and is precipitated by tan. The fibrina in this ſtate alſo is almoſt entirely diſſolved by ammonia, and the ſolution is of an orange colour. Fibrina is diſſolved in boiling nitric acid, in which ammonia produces a precipitate, compoſed chiefly of oxalate of lime. During the action of the nitric acid, pruſſic acid paſſes over, with carbonic acid gas and nitrous gas. Oxalic acid is formed, and a fatty matter appears on the ſurface. Fibrina is alſo ſoluble in muriatic acid, with which it forms a green-coloured jelly. It is diſſolved alſo in acetic, oxalic, tartaric, and citric acids, with the aſſiſtance of heat; and is converted, by concentrating the ſolutions, into a gelatinous maſs. Alkalies precipitate fibrina from its ſolution in the acids, in the form of flakes, which have the properties of gelatine, and are ſoluble in hot water.

5. Concentrated potaſh or ſoda, boiled upon fibrina, forms a deep brown coloured ſolution, which has the properties of ſoap. During the proceſs ammonia is given out.

6. Fibrina is compoſed of carbone, hydrogen, azote, and oxygen, but the proportions are unknown. It is found only in the blood and muſcular parts of animals.

IV. Of Urea.

1. The nature and properties of urea have been chiefly inveſtigated by Fourcroy and Vauquelin. It is obtained from urine. It may be extracted by the following proceſs.

2617 Method of preparing. If a quantity of human urine which has been paſſed a few hours after taking food, be evaporated with a gentle heat, to the conſiſtence of a thick ſyrup, and allowed to cool, it concretes into a cryſtalline maſs. Add to this maſs in ſeparate portions four times its weight of alcohol; with the application of a gentle heat, great part is diſſolved, and what remains conſiſts of different ſaline ſubſtances. Separate the ſolution from the undiſſolved part, and introduce it into a retort. Diſtill with the heat of a ſand-bath, and continue the boiling till the liquid is reduced to the form of a thick ſyrup. The matter which remains in the retort cryſtallizes as it cools. The cryſtals thus formed are *urea*.

2618 Properties. 2. Urea, which is prepared by this proceſs, is cryſtallized in the form of plates, croſſing each other. It is viſcid, reſembling thick honey, and of a yellowiſh white colour. It has a ſtrong acrid taſte, and a fetid alliaceous ſmell. It deliqueſces in the air, and by attracting moiſture is converted into a thick brown liquid. It is very ſoluble in water, and alſo in alcohol. The ſolution in water concentrated is of a brown colour. This ſolution is gradually decompoſed, air is emitted, which is partly compoſed of ammonia, and acetic acid is formed in the liquid. If the ſolution in water be boiled, and as the evaporation goes on freſh portions of water be added, the urea is decompoſed; carbonate of ammonia is diſengaged, while acetic acid is formed and charcoal precipitated.

2619 Action of heat. 3. By the action of heat urea ſoon melts, enlarges in bulk, and evaporates, emitting an extremely fetid ſmell,

ſmell. By diſtillation, benzoic acid firſt paſſes over, afterwards carbonate of ammonia, carbonated hydrogen gas, with a ſmall portion of pruſſic acid and oil. What remains behind conſiſts of charcoal, muriates of ammonia and of ſoda. The benzoic acid, the muriate of ammonia and muriate of ſoda, are conſidered as extraneous matter, ſo that the products of urea by diſtillation conſiſt of the carbonate of ammonia, carbonated hydrogen gas, and charcoal. The component parts of urea, therefore, are ſuppoſed to be.

2620 Compoſition.

Oxygen,	39.5
Azote,	32.5
Carbone,	14.7
Hydrogen,	13.3
	100.0

2621 Action of acids.

4. If one-fourth of its weight of diluted ſulphuric acid be added to the ſolution of urea, and heat be applied, an oily matter appears on the ſurface, which concretes on cooling. Acetic acid is found in the liquid which is collected in the receiver, and ſulphate of ammonia remains in the retort. The whole of the urea may be converted into acetic acid and ammonia by repeated diſtillation.

Nitric acid produces a violent effervеſcence with the cryſtals of urea. The liquid becomes dark red, and during effervеſcence nitrous gas, azotic gas, and carbonic acid gas are evolved. A concrete white matter remains after the effervеſcence has ceaſed, mixed with a ſmall portion of the red liquid. The reſiduum produces a detonation with the application of heat.

Urea is ſoluble in muriatic acid, but it remains unchanged. A diluted ſolution of urea abſorbs very rapidly oxymuriatic acid gas. Whitiſh flakes appear, which ſoon become brown, and adhere to the ſides of the veſſel. After the abſorption, the ſolution gives out carbonic acid and azotic gaſes. Muriate and carbonate of ammonia remain in the liquid after the effervеſcence ceaſes.

2622 Alkalies.

5. Urea is readily diſſolved in ſolutions of potaſh or ſoda. Ammonia is alſo diſengaged, when urea is diſſolved in ſolutions of barytes, lime, or magneſia. It is alſo diſengaged by triturating pure potaſh in the ſolid ſtate, with urea. Heat is produced at the ſame time. The mixture aſſumes a brown colour, and an oily matter is depoſited.

Muriate of ſoda diſſolved in a ſolution of urea in water, affords by evaporation cryſtals in the form of regular octahedrons; but muriate of ammonia diſſolved in the ſame way, cryſtallizes in the form of cubes.

V. Of Sugar.

2623 Extracted from milk.

1. Sugar has only been diſcovered among animal matters in milk and in the urine of perſons labouring under *diabetes*. Sugar is obtained from milk by evaporating freſh whey to the conſiſtence of honey. When it cools, it concretes into a ſolid maſs. This is to be diſſolved in water, and being previouſly clarified with the white of eggs, to be filtered and evaporated to the conſiſtence of ſyrup. Cryſtals of ſugar of milk are depoſited on cooling.

2624 Properties.

2. When ſugar of milk is pure, it is of a white colour, has a ſweetiſh taſte, but no ſmell. It cryſtallizes in the form of regular parallelopipeds, terminating in four-ſided pyramids. The cryſtals are ſemitranſparent. The ſpecific gravity is 1.543. It is ſoluble in ſeven times its weight of water.

2625 Action of heat.

3. When it is burnt, it exhibits the ſame appearances as vegetable ſugar, giving out at the ſame time the odour of caromel. Similar products are obtained by diſtillation as from vegetable ſugar; but the empyreumatic oil has the odour of benzoic acid.

2626 Acids.

4. By means of nitric acid the ſugar of milk is partly converted into ſaclactic acid.

2627 Method of obtaining it.

Sugar from diabetic urine.—This is obtained by evaporating the urine of perſons labouring under diabetes. One twelfth of the weight of urine of a ſweet-taſted ſubſtance of the conſiſtence of honey has been obtained by this proceſs. When this ſubſtance is treated with nitric acid, it affords oxalic acid in the ſame proportion as vegetable ſugar; but no ſaclactic acid is formed, as when ſugar of milk is treated in the ſame way. It has not been cryſtallized.

VI. Of Oils.

2628 In different ſtates.

1. The oils which have been detected in animals have the characters of fixed oils. Sometimes they exiſt in the ſolid ſtate, and ſometimes they are liquid. Fat is a copious animal production, which has different degrees of conſiſtence, as it is obtained from different animals. To purify it, it is cut into ſmall pieces, which are to be well waſhed with water, and the membranous and vaſcular parts ſeparated. It is then put into a ſhallow veſſel along with ſome water, and kept melted till the whole of the water is evaporated. It is then of a pure white colour, without taſte or ſmell.

2629 Action of heat.

2. It melts at different temperatures. Hogs lard requires only a temperature of 97°, while the fat extracted from meat by boiling requires a temperature of 127°. When the heat is raiſed to 400°, a white ſmoke is given out; as the heat increaſes it is decompoſed, and becomes black. When hogs lard is diſtilled in a retort, carbonated hydrogen and carbonic acid gaſes, accompanied with a very offenſive ſmell, paſs over. A portion of water is alſo obtained, and a white oil which concretes in the receiver. Acetic acid and a portion of ſebacic acid are alſo found in the receiver. A black maſs remains behind in the retort.

2630 Acids.

3. Fat is inſoluble in water and alcohol. It is diſſolved and decompoſed by the ſtrong acids. If nitric acid be poured upon fat, and a moderate heat applied, the acid is decompoſed, and the fat is converted into a yellow coloured ointment. Fourcroy calls this an oxide of fat; the oxygen of the acid having combined with the oily matter.

2631 Alkalies.

4. Fat combines with the alkalies in the ſame way as other oily ſubſtances, and with them it forms ſoap.

2632 Compoſition.

5. The conſtituent parts of fat, as appears from the products which are obtained from its decompoſition, are oxygen, hydrogen, and carbone.

There are beſides ſome other oily ſubſtances obtained from different parts of animals, as ſpermaceti from the head of the ſpermaceti-whale, ſpermaceti oil, which is ſeparated in the purification of the ſpermaceti, and train oil, extracted from the blubber of the whale, and from other ſea animals.

VII. Of Reſins.

1. Reſinous ſubſtances are found in different parts of animals, or rather they exiſt in thoſe ſubſtances which are ſecreted by animals.

2. A reſinous ſubſtance is extracted from the bile of animals. It is extracted from the freſh bile of the ox, by muriatic acid, in the proportion of one part of the latter to 32 of the former. The mixture remains for ſome hours, is filtered, and a white coagulated ſubſtance is ſeparated. The filtered liquid, which has a fine green colour, is to be evaporated in a glaſs veſſel with a gentle heat. The evaporation is continued till a green-coloured ſubſtance precipitates, which is to be ſeparated, and waſhed with pure water. This ſubſtance is the *reſin of bile*.

2633 Properties. 3. It is of a dark-brown colour, but when ſpread thin, is of a fine green. The taſte is extremely bitter.

2634 Action of heat. 4. When it is heated to the temperature of 122°, it melts. By increaſing the heat, it takes fire and burns. It is ſoluble in cold and hot water, and alſo in alcohol; but it is precipitated from the latter by water. The alkalies alſo diſſolve this ſubſtance, and form a compound which has the properties of ſoap. This ſubſtance is precipitated from all theſe ſolutions by means of diluted acids.

A reſinous ſubſtance has alſo been diſcovered in human urine, in ambergris, which will be afterwards deſcribed, and in caſtor, civet, and muſk.

VIII. Of Phoſphorus.

2635 Given out during putrefaction. During the putrefaction of animal matters, phoſphorus is given out in the ſtate of phoſphorated hydrogen gas, ſo that it muſt have entered as a conſtituent into theſe matters.

IX. Of Sulphur.

2636 Found in albumen. Albumen is always mixed with a portion of ſulphur. It has been detected in the white of eggs and in milk, in the blood, in the urine and fæces, in the muſcles and in the hair. According to Prouſt ſulphur exiſts in the blood, in combination with ammonia, forming a hydroſulphuret of ammonia.

X. Of Acids.

2637 Enumeration of acids. No leſs than 12 different acids have been detected ready formed in animal bodies. Theſe are,

Sulphuric,
Muriatic,
Phoſphoric,
Carbonic,
Acetic,
Oxalic,
Malic,
Benzoic,
Lactic,
Uric,
Roſacic,
Amniotic.

1. Sulphuric acid has been found combined with ſoda, forming ſulphate of ſoda, in the liquor of the amnios of cows. Sulphate of lime has been detected in the urine of quadrupeds.

2. Muriatic acid exiſts in combination with ſoda in almoſt all the animal fluids, forming muriate of ſoda.

3. Phoſphoric acid is found in great abundance in different parts of animals. The phoſphate of lime conſtitutes the baſis of the bones, and it exiſts alſo in almoſt all the ſolid parts of animals, and in moſt of the fluids. In the blood it is combined with iron.

4. Carbonic acid is found combined with lime in the urine of horſes and cows. It has alſo been detected in freſh human urine.

5. Acetic acid is found in urine; but it has been detected in great abundance in the red ant, and was formerly called *formic acid*, at leaſt combined with malic acid.

6. Oxalic acid has been found in urinary calculi.

7. Malic acid has been found in the liquid obtained from the red ant. This is obtained by bruiſing the ants, and macerating them in alcohol. The alcohol is driven off by diſtillation, and an acid liquid remains behind. By ſaturating this liquid with lime, and adding acetate of lead to the ſolution, a copious precipitate is formed, which is ſoluble in acetic acid, ſo that this liquid contains ſomething beſides acetic acid. If nitrate of lead be mixed with the acid liquid after it is ſaturated with lime, a precipitate is formed, which is the malic acid combined with lead.

8. Benzoic acid has been detected in human urine, and in conſiderable quantity in the urine of cows. It has been found in the blood, white of eggs, in glue, ſilk, or wool, in the ſponge, and in muſhrooms.

9. Lactic acid is obtained from milk, when it becomes ſour. It is alſo ſaid, that it has been found in new milk.

10. Uric acid exiſts in human urine, and forms one of the conſtituents of urinary calculi. One ſpecies of calculus, indeed, is compoſed entirely of this ſubſtance.

11. Roſacic acid is obtained from the urine of perſons labouring under fevers and other diſorders, when the urine depoſits what is called a *lateritious ſediment*.

12. Amniotic acid is obtained from the liquid of the amnios of the cow.

XI. Of Alkalies, Earths, and Metals.

2638 Alkalies. 1. The different alkalies have been found in animal fluids. Potaſh has been found in conſiderable abundance in the urine of quadrupeds. It has alſo been detected in the milk of cows. Soda is found in all the fluids. It is uſually mixed with albumen. It is frequently combined with the phoſphoric and muriatic acids. Ammonia alſo has been detected in urine.

2639 Earths. 2. The earths which have been detected in animals are, lime, magneſia, and ſilica. Lime forms, in combination with phoſphoric acid, the baſis of bones. It is alſo found in the ſame ſtate in the other ſolid parts, as well as in moſt of the fluids. The ſhells of animals are compoſed chiefly of carbonate of lime. Magneſia has been found in human urine, combined with phoſphoric acid and ammonia. It forms alſo one of the component parts of urinary calculi. Silica has only been found in ſimilar concretions.

2640 Metals. 5. The only metal which has been detected in animals is iron, in combination with phoſphoric acid, which forms a conſtituent part of the blood.

II. Fluid

II. Fluid Parts of Animals.

We ſhall treat of the animal fluids in the following order:

2641 Enumeration.

1. Blood,
2. Bile,
3. Urine,
4. Milk,
5. Saliva,
6. Tears and mucus of the noſe,
7. Humours of the eye,
8. Wax of the ear,
9. Synovia,
10. Semen,
11. Liquor of the amnios,
12. Fluids ſecreted by diſeaſe.

1. Of the Blood.

2642 Properties. 1. The blood is a fluid of a red colour, which circulates through the body, and is diſtributed by means of the arteries to every part of it, communicating, as we have ſeen, heat and nouriſhment. It is then reconveyed by the veins from the extremities to the heart. Human blood, and that of ſome other animals, is of a fine, purpliſh-red colour, has ſome degree of conſiſtency, ſoft and ſoapy to the feel, of a ſweetiſh ſaline taſte, and a peculiar odour. The blood is found to vary in conſiſtence, ſo that its ſpecific gravity alſo varies from 1.053 to 1.126.

2643 Separates into two parts. 2. When blood, after it has been ſeparated from the body, remains for ſome time at reſt, it ſeparates into two parts. One part called the *clot* or *cruor*, is coagulated, and continues of a red colour; the other part, called the *ſerum*, remains fluid. The uſual proportion of cruor to ſerum, is about one part of the former to three of the latter. This proportion, however, is ſubject to conſiderable variation.

2644 Action of acids. 3. The acids alſo coagulate blood, and decompoſe it. Concentrated ſulphuric acid occaſions a brown colour, with the production of charcoal. It is coagulated by nitric acid, with the evolution of azotic gas, and the production of carbonic and oxalic acids, beſides ſome unctuous matter. Muriatic acid alſo coagulates blood, but without any perceptible change of colour. Oxymuriatic acid renders it as black as ink. Acetic acid alſo produces a coagulation.

2645 Alkalies. 4. The cauſtic alkalies diſſolve the coagulum of blood, even when it has been produced by acids. If they are mixed with blood recently drawn, the coagulation is interrupted. Many ſaline bodies produce a ſimilar effect by preventing coagulation, or decompoſition.

2646 Metallic oxides. 5. The metallic oxides have little perceptible action on blood, except thoſe which readily part with their oxygen. It is then coagulated. Almoſt all metallic ſolutions coagulate blood, and have the property, as well as the alkaline ſalts, of preſerving it from putrefaction.

2647 Vegetable productions. 6. Many vegetable ſubſtances when mixed with blood, prevent its putrefaction, ſuch as ſugar, volatile oils, camphor, reſins. It is coagulated by ſolutions of gum and of ſtarch. Tan produces a copious precipitate in blood, and gallic acid gives a black colour, owing to the iron which is contained in blood. The latter precipitate may be obtained by diluting the blood with a conſiderable proportion of water.

2648 Serum. 7. Blood, by remaining at reſt, it has been obſerved, ſeparates into two parts, the ſerum and the cruor. The ſerum is of a pale, greeniſh, yellow colour, of a thinner conſiſtence than blood; but retains its taſte, ſmell, and ſoapy feel. The ſpecific gravity is about 1.0287. In conſequence of its containing a portion of ſoda, it gives a green colour to ſyrup of violets. Serum coagulates at the temperature of 156°. The ſame effect is produced by adding boiling water. This coagulum is of a grayiſh white colour, reſembling the white of eggs. By breaking the coagulum to pieces, a fluid may be expreſſed from it, which has been called the *ſeroſity* of blood. The reſiduum being waſhed with boiling water, exhibits the properties of albumen.

2649 Gelatine. 8. By diluting ſerum with ſix times its weight of water, and boiling it, the albumen is coagulated. If the remaining liquid be evaporated with a gentle heat, till it is conſiderably concentrated, it aſſumes the form of jelly, and this poſſeſſes the properties of gelatine.

2650 Sulphur. 9. By heating the coagulated ſerum in a ſilver veſſel, the ſilver is blackened, in conſequence of its converſion into a ſulphuret, by combining with ſulphur contained in the coagulum. It has been already mentioned, that this ſulphur exiſts in the blood, in combination with ammonia, in the ſtate of hydroſulphuret.

2651 Different ſalts. 10. The ſerum of blood contains muriate of ſoda, carbonate of ſoda, phoſphate of ſoda, and phoſphate of lime. Theſe ſalts may be obtained by mixing ſerum with double its weight of water, applying heat to coagulate the albumen, which being ſeparated, and the remaining liquid filtered and evaporated, cryſtals are depoſited on cooling. The ſoda exiſts in blood combined with gelatine and albumen, and is in its cauſtic ſtate. It unites with the carbonic acid of the air during the evaporation. The component parts of ſerum, therefore, are the following.

2652 Compoſition of ſerum.

Albumen,
Gelatine,
Hydroſulphuret of ammonia,
Soda,
Muriate of ſoda,
Phoſphate of ſoda,
Phoſphate of lime.

2653 Cruor. 11. The cruor or clot of the blood, the other portion into which it ſpontaneouſly ſeparates, is of a red colour, and has conſiderable conſiſtence. Its ſpecific gravity is about 1.245. By waſhing this ſubſtance with a ſmall quantity of water, and continuing the proceſs till the water paſſes off colourleſs, part of it is diſſolved by the water, and part remains in the ſtate of a ſolid white elaſtic ſubſtance, which is the fibrina of the blood. That part which is held in ſolution by the water contains the colouring matter. This ſolution converts the ſyrup of violets to a green colour. By expoſure to the air it depoſits albumen in the form of flakes. By the evaporation of this ſolution to dryneſs, and the addition of alcohol, part is diſſolved. 2654 Albumen and ſoda. If this ſolution be evaporated, the reſiduum converts vegetable blues to green, and mixes with water like ſoap. This reſiduum contains albumen and ſoda.

2655 Iron. 12. If the watery ſolution be evaporated to dryneſs with a moderate heat, a quantity of iron remains behind, which may be ſeparated by the magnet. It has been ſaid that the quantity of iron in the blood of a healthy man amounts to more than two ounces; but

this

2656 Quantity conjectured.

this is little better than conjecture, founded on vague calculation. The iron in blood is combined with phoſphoric acid. If the watery ſolution be evaporated to dryneſs, and the reſiduum obtained be calcined in a crucible, a red maſs remains, which amounts to 0.0045 of the blood which was employed. Part of this reſiduum, which is phoſphate of iron, is diſſolved by digeſtion in nitric acid. From this it is precipitated of a white colour, by ammonia. With the addition of pure potaſh, the precipitate becomes red. By adding lime water to the ſolution which contains the potaſh, a precipitate is formed, which is phoſphate of lime. By the action of theſe re-agents, it appears that the iron in the blood combined with phoſphoric acid, is in the ſtate of ſub-phoſphate. Phoſphate of iron is inſoluble in water, but ſoluble in the acids. It is partially decompoſed by the alkalies, which carry off part of its acid, and leave the remainder with exceſs of iron. Thus it is that this ſalt is preſerved in the ſtate of ſub-phoſphate, by means of the ſoda which exiſts in the blood.

2657 Fibrina.

13. The method of obtaining fibrina from blood has been already deſcribed. This ſubſtance may be ſeparated by agitating, or ſtirring rapidly with a ſtick, the blood which has been newly drawn from the animal. The fibrina or fibrous matter being well waſhed and dried on paper, loſes about two-fifths of its weight, and becomes hard and brittle. The mean proportion of fibrina in the blood of man has been eſtimated at 0.0028. The fibrina is formed in the blood as it paſſes through the lungs, and is depoſited in the muſcular parts of animal bodies, of which it forms one of the principal conſtituents. When the fibrina is ſeparated from the blood, the latter is no longer diſpoſed to coagulate when it is left at reſt. A flaky matter only is ſeparated, which appears on the ſurface.

2658 Diſtillation.

14. Blood dried with a moderate heat, exhales a quantity of water which poſſeſſes a peculiar odour, owing to a portion of animal matter which it holds in ſolution. If the blood thus dried be diſtilled in a retort a watery fluid paſſes over, afterwards carbonic acid gas, carbonate of ammonia, which cryſtallizes in the neck of the retort, a fluid oil, carbonated hydrogen gas, and an oily matter of the conſiſtence of butter. A green powder is precipitated from ſulphate of iron by the watery fluid. A portion of this powder is ſoluble in muriatic acid, and a ſmall quantity of Pruſſian blue remains behind, from which it appears that pruſſic acid and an alkali are contained in the watery liquor.

2659 Action of heat.

A quantity of dried blood amounting to 9216 grs. was introduced into a large crucible, and being gradually heated, it became at firſt nearly fluid; it then ſwelled up, gave out abundance of yellowiſh-coloured fetid fumes, and at laſt took fire, and burnt with a white flame. The flame and the fumes ceaſing to be emitted, were ſucceeded by a light, acrid ſmoke, which had the odour of pruſſic acid. When the matter had been deprived of about five-ſixths of its weight, at the end of ſix hours it melted again; a purple flame appeared on the ſurface, with the evolution of denſe acrid fumes, which being collected were found to poſſeſs the properties of phoſphoric acid. One hundred and eighty-one grains of a deep black colour and metallic brilliancy conſtituted the reſiduum. It was attracted by the magnet. From theſe obſervations it appears that the conſtituent parts of the blood are the following.

2660 Compoſition.

1. Water.
2. Fibrina.
3. Albumen.
4. Gelatine.
5. Hydroſulphuret of ammonia.
6. Soda.
7. Subphoſphate of iron.
8. Muriate of ſoda.
9. Phoſphate of ſoda.
10. Phoſphate of lime.
11. Benzoic acid.

2661 Varies at different periods, &c.

15. The conſtituent parts of blood vary conſiderably at different periods of life, and in different ſtates of the body. The colouring matter of the blood of the fœtus has been found to be darker and more copious. It contains no fibrina or phoſphoric acid.

2662 Inflammatory.

16. The blood of perſons labouring under inflammatory diſorders ſeems to poſſeſs different properties from that of perſons in health. It then exhibits, ſoon after it is drawn from the body, what has been called by phyſicians the *buffy coat*, which is conſidered to be the characteriſtic of inflammation. This inflammatory cruſt has been found to conſiſt of fibrina, ſo that the cruor deprived of this matter, becomes ſoft, and is almoſt entirely ſoluble in water. The albumen of the ſerous part has alſo undergone ſome changes. It aſſumes a milky appearance when mixed with hot water, and does not coagulate when it is heated.

2663 Diabetic.

17. The ſerum of the blood of perſons labouring under diabetes, is deprived of its ſaline taſte, has the appearance of whey, and ſomewhat of a ſaccharine taſte.

II. Of Bile.

2664 Importance and properties.

1. Bile is an important fluid in the animal economy. It ſeems to perform an eſſential part in the function of digeſtion. It is ſecreted from the liver, and is of a yellowiſh-green colour, has a ſoapy feel, a bitter taſte, and a peculiar odour; but it varies in colour, and in ſome other of its properties, in different animals. It varies alſo in its ſpecific gravity. It has been eſtimated at 1.0246. The experiments which have been made on bile relate chiefly to that obtained from the gall-bladder of the ox, hence denominated *ox-gall*. When bile is ſtrongly agitated, it forms a lather like ſoap, and hence it has been called an *animal ſoap*. It mixes in all proportions with water, to which it communicates a yellow colour.

2665 Action of heat.

2. When bile is expoſed to a moderate heat, it becomes thick, having loſt a great part of its weight. The vapour it exhales has a peculiar offenſive odour. A ſolid brown maſs is thus obtained, which has a bitter, with ſomewhat of a ſweetiſh taſte, becomes ſoft with the heat of the hands, is ductile, attracts moiſture from the air, and is ſoluble in water. This ſubſtance effervеſces ſlightly with acids, and acquires a perceptible odour of muſk or amber, when kept for ſome time. This has been called the *extract of bile*. When this proceſs is conducted in cloſe veſſels, with the heat of a water bath, it gives out a clear aqueous fluid of a diſagreeable odour, which undergoes no particular change by means of re-agents, if the diſtillation has not been carried too far, or the bile has not become in ſome degree putrid. If this latter circumſtance has taken place,

Component Parts of Animal Subſtances.

place, the watery product has frequently a ſtrong odour of muſk, and becomes turbid on cooling.

2666 Diſtillation.

When this extract of bile is heated in a retort, it is decompoſed with peculiar appearances. When heat is gradually applied, a watery fluid, which is ſlightly muddy, and of a fetid odour, paſſes over. This fluid precipitates metallic ſalts, and contains almoſt always ſulphurated hydrogen. The matter in the retort enlarges in volume, and the fluid which then comes over is of a brown colour, extremely fetid, and contains carbonate and zoonate of ammonia. Soon after an oil is evolved, which is at firſt liquid, and afterwards becomes of a browniſh colour, thick, and empyreumatic, and of a moſt offenſive fetid odour. At the ſame time carbonate of ammonia cryſtallizes on the ſides of the receiver. There is then a copious evolution of an elaſtic fluid, compoſed of carbonic acid, carbonated and ſulphurated hydrogen gaſes, holding in ſolution a ſmall portion of oil. The carbonate of ammonia thus obtained, does not amount to the one-eighth part of the quantity which is extracted from the blood and from the bones of animals, from which it is ſuppoſed that the bile is leſs animalized than many other animal ſubſtances. There remains behind a black ſpongy maſs of coal, which is eaſily burnt. This coaly matter, by expoſure to the air, effloreſces on the ſurface, which is found to be carbonate of ſoda. When it is well burnt, it preſerves a deep gray colour; and there is ſeparated, by means of cold water, nearly half its weight of carbonate of ſoda, a little muriate of ſoda, phoſphate of ſoda, phoſphate of lime, with ſome traces of iron.

2667 Action of acids.

3. Bile is decompoſed by all the acids. A precipitate is formed, which is always of a green colour. Part of this precipitate remains ſuſpended in the ſolution, and is even diſſolved by agitation. The ſolution being filtered, leaves on the filter a portion of coagulated albumen. By evaporation the liquid depoſits a deep green flaky ſubſtance like pitch, which has conſiderable tenacity, ſwells up when put upon hot coals, readily takes fire, and burns like reſinous matter. After the ſeparation of this matter, the liquid affords by evaporation, a ſalt with a baſe of ſoda.

Three different ſaline ſubſtances have been obtained by the action of acids on bile; the firſt with a baſe of ſoda, the ſecond which cryſtallizes in ſmall needles has lime for its baſe, and the third is a cryſtalline matter, of a ſlightly ſweet taſte, which is ſuppoſed to be ſimilar to ſugar. Thus it appears that acids act on bile in three different ways; they coagulate the albumen, which is precipitated; they combine with the ſoda, by ſeparating the oily matter which conſtituted the ſaponaceous part of the bile; and they decompoſe the phoſphoric ſalts.

Concentrated ſulphuric acid coagulates bile in the form of denſe flakes, and communicates to it a deep colour. Nitric acid, after having formed a precipitate of a green colour in the cold, aſſumes a golden yellow colour, when it is heated for a ſufficient length of time. It converts a portion of bile into oxalic and pruſſic acids. Muriatic acid at firſt produces a green precipitate, which afterwards aſſumes a ſhade of a reddiſh violet colour, eſpecially by means of heat. Oxymuriatic acid renders it white and turbid like milk. It changes the properties of the different conſtituents of bile, and occaſions a precipitate ſimilar to that matter which frequently conſtitutes *biliary calculi*.

2668 Phoſphate of lime.

4. When the precipitate from bile by means of the acids is treated with alcohol, and every thing ſoluble in this liquid ſeparated, there remains a whitiſh matter, which is infuſible, nearly inſipid, inſoluble, whether with cold or hot water, but ſoluble in ſolutions of the cauſtic fixed alkalies, which burns on red-hot coals with the odour of horn, and which gives by analyſis, ſimilar products, eſpecially carbonate of ammonia in conſiderable quantity. The coal which remains contains a portion of phoſphate of lime.

2669 Action of alkalies.

5. The alkalies deprive bile of its bitter taſte; but they do not coagulate it.

6. Thus it appears that the conſtituent parts of bile are the following.

Water,
Albumen,
Reſin,
Soda,
Sulphurated hydrogen,
Saccharine matter,
Muriate of ſoda,
Phoſphate of lime,
Phoſphate of ſoda,
Iron.

2670 Uſes.

7. Bile, it has been already obſerved, performs an important part in the function of digeſtion. The albuminous and ſaline parts combine with the chyle, and are conveyed to the blood. The reſinous portion combines with the excrementitious part of the chyle, and is thrown out of the body.

Bile is employed in the arts for removing ſpots of greaſe and oil from woollen ſtuffs. It is alſo employed as a pigment. It is evaporated and reduced to the form of extract, and diluted with a little water, in which ſtate it gives a brown colour.

III. Of Urine.

2671 Properties.

1. The properties of urine vary conſiderably, according to the conſtitution and health of the body, and the period when it is voided after taking food. The urine of a healthy perſon is of a light orange colour, and uniformly tranſparent. It has a ſlightly aromatic odour, in ſome degree reſembling that of violets. It has a ſlightly acrid, ſaline, bitter taſte. The ſpecific gravity varies from 1.005 to 1.033. The aromatic odour, which leaves it as it cools, is ſucceeded by what is called the *urinous ſmell*, which latter is converted to another, and finally, to an alkaline odour. Urine converts the tincture of turnſole into a green colour, from which it is concluded, that it contains an acid.

2672 Phoſphate of lime.

2. By adding a ſolution of ammonia to freſh urine, a precipitate is formed in the ſtate of white powder, which is found to be phoſphate of lime. But if lime water be employed in place of ammonia, a more copious precipitate, of phoſphate of lime, is obtained, from which it is concluded, that the phoſphate of lime is held in ſolution with an exceſs of acid.

2673 Phoſphate of magneſia.

3. A ſmall portion of magneſia is alſo found mixed with the phoſphate of lime which has been precipitated, derived from phoſphate of magneſia, which has been decompoſed by the alkali or lime.

2674 Carbonic acid.

4. The froth which appears when urine is evaporated is aſcribed to the evolution of carbonic acid gas.

2675 Carbonate of lime.

5. Urine which has been kept in new caſks, depoſits

its ſmall cryſtals, which effloreſce in the air. Theſe cryſtals have been found to poſſeſs the properties of carbonate of lime.

2676 Uric acid.

6. A brick-coloured precipitate is frequently formed in urine as it cools. This ſubſtance is uric acid, which exiſts in all urine, and may be obtained by evaporating freſh urine, diſſolving it in pure alkali, and precipitating by means of acetic acid.

2677 Roſacic acid.

7. The urine of perſons labouring under intermitting fevers, and ſome other diſeaſes, depoſits a copious ſediment called the lateritious ſediment, which conſiſts of roſacic acid.

2678 Benzoic acid.

8. Benzoic acid alſo exiſts in urine. It is obtained by evaporating freſh urine to the conſiſtence of a ſyrup, and adding muriatic acid. A precipitate is thus formed, which is benzoic acid. But it may be obtained by evaporating urine to dryneſs, ſeparating the ſaline ſubſtances, and applying heat to the reſiduum. By this proceſs the benzoic acid is ſublimed, and cryſtallized in the receiver. The quantity of benzoic acid is more conſiderable in the urine of horſes and cows than in human urine.

2679 Albumen and gelatine.

9. Albumen or gelatine has been found in urine, and is precipitated by means of an infuſion of tan. The cloud which appears as urine cools, conſiſts of theſe ſubſtances, which are increaſed in proportion during different diſeaſes. The urine of perſons labouring under dropſy contains a large quantity of albumen; and in the urine of thoſe perſons who are ſubject to indigeſtion, the albumen and gelatine are greatly increaſed.

2680 Urea.

10. Urea is the principal conſtituent of urine. The method of obtaining it from urine has been already deſcribed. It is to this ſubſtance that the taſte, ſmell, and peculiar characters of urine are owing. If concentrated nitric acid be poured upon urine, evaporated to the conſiſtence of ſyrup, cryſtals appear, which are the nitrate of urea. The quantity of urea ſecreted is very different in different circumſtances.

2681 Reſin.

11. A reſinous ſubſtance reſembling the reſin of bile has been detected in urine, to which its colour is aſcribed. Urine evaporated to the conſiſtence of extract, mixed with ſulphuric acid and diſtilled, gives out this reſinous matter, which is ſoluble in water and in alcohol. When urea has been ſeparated from urine by evaporation and cryſtallization, a ſaline maſs remains. If this be diſſolved in hot water, and ſpontaneouſly cryſtallized in a cloſe veſſel, two kinds of cryſtals are depoſited. Thoſe at the bottom are in the form of rhomboidal priſms, and conſiſt of phoſphate of ammonia mixed with a little phoſphate of ſoda. The cryſtals in the upper part of the veſſel are in the form of rectangular tables, compoſed chiefly of phoſphate of ſoda. Theſe were formerly called *ſable ſalt of urine*, *microcoſmic ſalt*.

2682 Muriate of ſoda.

12. Muriate of ſoda was the firſt ſaline ſubſtance detected in urine. It may be obtained by ſlowly evaporating it to the conſiſtence of ſyrup. The ſalt cryſtallizes upon the ſurface, but in this caſe the form of the cryſtal is that of an octahedron, and not the cube, the uſual form. The cauſe of this deviation is aſcribed to the urea.

2683 Muriate of potaſh.

13. Muriate of potaſh is alſo found among the cryſtals which are formed during the evaporation of urine.

2684 Muriate of ammonia.

14. Muriate of ammonia is one of the ſalts which are found in urine. The cryſtals of this ſalt which are uſually octahedrons, when they are formed in urine aſſume that of the cube, a deviation which is alſo aſcribed to the action of the urea.

2685 Sulphur.

15. Urine contains ſulphur, which may be detected by holding paper ſtained with acetate of lead over urine when it is become putrid. The paper is blackened, which is owing to ſulphur exhaled with the carbonic acid. Sulphate of ſoda and ſulphate of lime have alſo been detected in urine.

2686 Component parts.

16. No leſs than 30 different ſubſtances have been detected in urine by chemical analyſis, the principal of which are the following.

Water,
Phoſphoric acid,
Phoſphate of ſoda,
Phoſphate of ſoda and ammonia,
Phoſphate of ammonia,
Phoſphate of lime,
Phoſphate of magneſia,
Phoſphate of magneſia and ammonia,
Carbonic acid,
Carbonate of lime,
Uric acid,
Urate of ammonia,
Roſacic acid,
Benzoic acid,
Benzoate of ammonia,
Gelatine,
Albumen,
Urea,
Reſin,
Muriate of potaſh,
Muriate of ſoda,
Muriate of ammonia,
Sulphur,
Sulphate of lime,
Sulphate of ſoda.

2687 Putrefaction of urine.

17. Urine is much diſpoſed to ſpontaneous decompoſition. The time when this proceſs commences, and the rapidity of the changes which take place, depend on the quantity of the gelatine and albumen. When the proportion of theſe ſubſtances is conſiderable, the decompoſition is very rapid. This is owing to the great number of ſubſtances, and the united force of their attractions overcoming the exiſting affinities of the different compounds of which freſh urine conſiſts, and eſpecially to the facility with which urea is decompoſed. This ſubſtance is converted during putrefaction into ammonia, carbonic acid, and acetic acid. Hence the ſmell of ammonia is always recognized while urine is undergoing theſe changes. Part of the gelatine is depoſited in a flaky form mixed with mucilage. Ammonia combines with phoſphoric acid, and the phoſphate of lime is precipitated. It combines alſo with phoſphate of magneſia, and forms a triple ſalt. The other acids, the uric, benzoic, the acetic and carbonic acids, are all ſaturated with ammonia. The following ſubſtances, therefore, are obtained from urine by putrefaction.

Ammonia,
Phoſphate of ammonia,
Phoſphate of magneſia and ammonia,
Carbonate of ammonia,
Urate of ammonia,
Acetate of ammonia,
Benzoate of ammonia,
Muriate of ammonia,
Muriate of ſoda.

Products nearly ſimilar are obtained by diſtillation of urine.

18. Such are the properties of human urine in its healthy ſtate; the changes to which it is ſubject, and the products which are obtained, either by means of chemical analyſis or ſpontaneous decompoſition.

2688 Varies in different circumſtances. But the nature and properties of urine vary conſiderably, according to the period of life, the time it is voided after taking food, different ſeaſons of the year, the nature of the food, the influence of paſſions, and diſeaſe.

2689 Urine of infants. In the urine of infants, no phoſphate of lime is found. The proportion of benzoic acid is conſiderable, and the quantity of urea is ſmall. There is leſs acrimony, odour, and colour. As the period of life advances, the ſaline matters increaſe, eſpecially the phoſphate of lime, which is no longer required for the formation of bone.

2690 After taking food. The urine, which is paſſed immediately after taking food, is white and colourleſs, and ſeems to contain little elſe but water. It is not till ſeven or eight hours after a repaſt, that the urine is completely formed.

2691 In warm ſeaſons. Urine voided during the warmer ſeaſons of the year, or by perſons who inhabit hot climates, is high-coloured and acrid, which is aſcribed to a greater proportion of ſaline matter and urea. In winter alſo the urine is red and high-coloured, owing to a greater proportion of the earthy phoſphates and of uric acid, which it then contains. It is no doubt conſiderably influenced by the modification of the action of the ſkin.

2692 Kinds of food. The food frequently communicates its properties to the urine. The odour of garlic, of reſinous ſubſtances and ſome aromatics, is often perceptible in the urine a few minutes after theſe ſubſtances are taken into the ſtomach, or even only applied to the ſkin. The fetid odour of the urine of thoſe who have eaten aſparagus, is well known. The colouring matters of ſome ſubſtances are communicated to the urine; ſuch as the red colour of beet-root, the orange-yellow of rhubarb, or the colour of madder.

2693 Paſſions. The paſſions of the mind have great influence on the ſecretion of urine, both in changing its properties, and increaſing its quantity. In theſe caſes the urine is generally colourleſs, inſipid, and without odour.

2694 Diſeaſes. But the nature and properties of urine undergo ſtill greater changes during diſeaſe. From theſe changes the empiric has attempted to form prognoſtics of the nature, progreſs, and termination of diſeaſes.

At the commencement of fevers and inflammatory diſorders, the urine is high-coloured and extremely acrid, ſcarcely becomes turbid on cooling, and depoſits no ſediment. In affections of the liver, ſuch as jaundice, it is of a yellow orange colour, like ſaffron, and communicates its colour to the veſſels into which it is received, or to thoſe ſubſtances which are immerſed in it. It is then called *bilious urine*. It ſeems to contain a portion of the colouring matter of bile. Towards the termination of febrile diſorders, the quantity of urine is increaſed, and it depoſits, as it cools, a cryſtalline or ſcaly matter, of the colour of peach flowers, which is called *critical urine*. The ſediment is compoſed of phoſphate of lime, roſacic and uric acids. During nervous affections, as in hyſteria, the urine is perfectly limpid and colourleſs, inodorous and inſipid. It has been obſerved, that the urine of gouty perſons contains a ſmaller proportion of acid than uſual. At the commencement of a paroxyſm, the quantity of phoſphoric acid ſeems to be diminiſhed; but it gradually increaſes towards the termination of the fit, and is then in greater proportion than in ordinary health. The urine of perſons labouring under rickets, depoſits a great portion of lime. The urine of an infant who died of worms, was found on analyſis to contain oxalate of lime. In ſome caſes of diabetes, the urine is colourleſs and inſipid; in others it contains a great proportion of ſaccharine matter.

2695 Different animals. 19. The urine of other animals exhibits different characters from that of man, according to their nature, the diverſity of their organs, their food, manner of reſpiration, and the medium in which they live.

2696 The horſe. The urine of the horſe has a ſtrong peculiar odour. It is turbid when voided, or ſoon after becomes muddy. A pellicle, which is carbonate of lime, forms on the ſurface when it is expoſed to the air. It changes the ſyrup of violets to a green colour, effervеſces with acids, and is precipitated by the alkaline carbonates. The urine of the horſe yields no phoſphorus. The component parts of the urine of this animal, as they have been aſcertained by Fourcroy and Vauquelin, are the following:

Carbonate of lime,	0.011
Carbonate of ſoda,	0.009
Benzoate of ſoda,	0.024
Muriate of potaſh,	0.009
Urea,	0.007
Water and mucilage,	0.940
	1.000 *

2697 The cow. The urine of the cow poſſeſſes nearly the ſame properties as that of the horſe. It has a ſoapy feel, and a ſtrong peculiar odour. It gives a green colour to ſyrup of violets, effervеſces with acids, but is not altered by the alkaline carbonates. When it is expoſed to the air, ſmall cryſtals form on the ſurface. Its component parts are,

Carbonate of potaſh,
Sulphate of potaſh,
Muriate of potaſh,
Benzoic acid,
Urea.

2698 The camel. The urine of the camel is more diſtinguiſhed by its odour than any other, but it is analogous to that of the cow. It is not mucilaginous, and does not depoſit carbonate of lime. The ſpecific gravity of this urine is greater than any other. It produces a ſlight change on the infuſion of violets, communicating a green colour. It effervеſces with acids, and furniſhes nitre, ſulphate and muriate of potaſh, with the addition of ſulphuric, nitric, and muriatic acids. It contains

Carbonate of potaſh,
Sulphate of potaſh,
Muriate of potaſh,
Urea.

2699 The rabbit. The urine of the rabbit, examined by Vauquelin, exhibits

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* Mem. de l'Inſt. ii. p. 445.

exhibits ſimilar characters with that of the horſe, the cow, and the camel. It becomes milky, and depoſits carbonate of lime by expoſure to the air. It converts vegetable blues to a green colour, and effervеſces with acids. It contains the following ſubſtances.

Carbonate of lime,
Carbonate of magneſia,
Carbonate of potaſh,
Sulphate of potaſh,
Sulphate of lime,
Muriate of potaſh,
Urea,
Gelatine,
Sulphur.

2700 Guinea pig. The urine of the Guinea pig is analogous in its nature and properties to that of the larger animals already deſcribed.

2701 Graminivorous animals. It appears that the urine of graminivorous animals belonging to the claſs of mammalia, or which live on vegetables in general, contains no phoſphoric ſalts, or uric acid; that it is loaded with carbonate of lime, ſalts having a baſe of potaſh, and benzoic acid. The only ſubſtance which the urine of theſe animals poſſeſſes in common with human urine, is urea. 2702 Carnivorous. The urine of carnivorous animals, of which indeed ſcarcely any thing is known, is ſuppoſed to poſſeſs different properties from that of the animals juſt mentioned. The ſtrong fetid odour of the urine of the cat is well known. Muriate of ammonia has been obtained from the urine of this animal by evaporation; but it is ſuppoſed, from the peculiar odour, that it contains urea.

2703 Of birds. The urine of birds affords a copious ſediment, which ſeems to be carbonate of lime.

2704 Turtle. A ſubſtance which was found in the urinary bladder of the turtle in the form of paſte, and which was examined by Vauquelin, was compoſed of

Muriate of ſoda,
Phoſphate of lime,
Animal matter,
Uric acid.

IV. Of Milk.

2705 Properties. 1. Milk, which is ſecreted in particular organs by the females of viviparous quadrupeds and cetaceous fiſhes, included under the claſs *mammalia*, and deſtined for the nouriſhment of the offspring, is a white opaque fluid, varying in its properties, according to the different ſpecies of animals, and the nature of their food. The milk of the cow, which is moſt eaſily and moſt abundantly procured, has been chiefly the ſubject of chemical inveſtigation. To it, therefore, the following obſervations are chiefly applied.

2706 Of cows milk. 2. Milk is diſtinguiſhed by an agreeable ſweet taſte, and a peculiar ſmell. But theſe properties belong to it only when it is juſt ſeparated from the cow, for in the courſe of a few hours they are conſiderably different. The ſpecific gravity varies at different periods. It is greater than that of water, and has been found to amount to 1.0324. The boiling and the freezing points of milk are alſo variable.

2707 Separation of cream. 3. If milk be left at reſt for ſome time, it ſeparates into two parts; an unctuous matter, which floats on the ſurface, called *cream*, and a denſer fluid which ſtill retains many of the properties of milk. The quantity of cream obtained from milk, and the time it requires to ſeparate, vary according to the nature of the milk and the temperature.

2708 Its properties. 4. Cream thus obtained is of a yellow colour, and acquires a greater conſiſtence by being expoſed to the air. It is lighter than water, has an unctuous feel, and becomes rancid like oils, by keeping. When it is boiled, a ſmall portion of oil appears on the ſurface. Cream is not ſoluble in alcohol or in oils. When cream is agitated for a longer or ſhorter time, according to the temperature to which the milk has been expoſed during its ſeparation, and perhaps to ſome circumſtances which have not yet been obſerved, it ſeparates into two parts; one, which has a ſolid conſiſtence, is butter, and another which remains fluid.

2709 Butter. 5. Butter is of a yellow colour, and has all the properties of an oil, combined with a portion of the curd and ſerum of the milk. It melts at the temperature of 96°, and mixes readily with other oily matters. When butter is kept for ſome time, it is decompoſed; it becomes rancid, which is aſcribed to the whey and the curd with which it is combined; for when theſe ſubſtances are previouſly ſeparated, it may be preſerved ſweet much longer. Butter yields by diſtillation water, an acid liquid, an oily ſubſtance, which is at firſt fluid, but becomes afterwards concrete. A ſmall portion of carbonaceous matter remains behind.

2710 Changes in the proceſs of churning. 6. When freſh cream, or the whole of the milk freſh drawn from the cow, is churned, it requires the proceſs to be continued a much longer time than when the cream or milk is left to repoſe, as is uſually the caſe, till it has acquired a ſlightly acid taſte. But when cream, which has become ſour, is churned, the butter ſeparated has no acid properties, and the milk which remains is even leſs ſour than the cream previous to the commencement of the proceſs. An acid, therefore, has been evolved, and this acid is ſuppoſed to be the carbonic. When freſh cream or freſh milk is ſubjected to this proceſs, in which the acid has not been formed, it requires greater agitation to complete this previous part of the change which the cream or milk muſt undergo, before the ſeparation of the oily part or the butter. The milk which remains after the butter has been ſeparated, or, as it is called, the butter-milk, has all the properties of milk from which the cream has been ſeparated.

2711 Coagulation. 7. The milk which remains after the ſeparation of the cream, may be coagulated by the addition of ſeveral ſubſtances, particularly by the addition of rennet, which is in moſt common uſe, and which is prepared by digeſting the inner coat of the ſtomach of young animals, eſpecially that of the calf. This coagulum ſeparates into two parts, the curd and the ſerum or whey.

2712 Curd. Curd is a white ſolid ſubſtance, and ſomewhat brittle, when the whole of the whey is expreſſed. It is ſoluble in acids, but it is neceſſary that the mineral acids be greatly diluted, and the vegetable acids concentrated.

2713 Cheeſe. Cheeſe is prepared from curd, by ſeparating the whey by expreſſion. The quality of the cheeſe depends upon the quantity of cream which remains in the milk,

milk. The beſt cheeſe is obtained by coagulating the milk at the temperature of about 100°, and expreſſing the whey ſlowly and gradually, without breaking down the curd.

If milk be not too much diluted with water, it may be coagulated by a great number of different ſubſtances. Among this number are acids, alcohol, neutral ſalts, gum arabic, and ſugar.

2714 Whey. 8. Whey expreſſed from coagulated milk is of a yellowiſh green colour, and has an agreeable ſweet taſte. If it is boiled, a quantity of curd ſeparates, and after being left at reſt for ſome time, the whole of it is precipitated, and the liquid remains tranſparent and colourleſs. By ſlow evaporation it depoſits white-coloured cryſtals of ſugar of milk, with ſome muriate of potaſh, muriate of ſoda, and a little phoſphate of lime. The liquid which remains after the ſeparation of the ſalts, is converted, by cooling, into a gelatinous ſubſtance. If whey be kept for ſome time, it becomes ſour, by the formation of an acid, which is lactic acid. It is to this acid that the ſpontaneous coagulation of milk, after it remains at reſt for ſome time, is owing.

2715 Koumiſs. 9. If milk, after it has become ſour, be kept in a proper temperature, it ferments, emitting carbonic acid gas, and exhibiting the other phenomena of fermentation. A vinous intoxicating liquor is thus prepared, which has been long known among the Tartars, and called by them *koumiſs*. They prepare it from the milk of the mare.

2716 Vinegar. 10. Milk is ſuſceptible of the acetous fermentation. If about ſix ſpoonfuls of alcohol be added to eight pints of milk, and the liquid be excluded from the air, vinegar will be formed in four or five weeks. Although the air is to be excluded, yet the carbonic acid gas muſt be allowed to eſcape as it is diſengaged.

By the diſtillation of milk with the heat of a water-bath, water paſſes over, after which the milk coagulates, and an oily yellowiſh white ſubſtance remains behind, which, by increaſing the heat, yields a tranſparent liquid, a fluid oil, ammonia, an acid, a thick black oil, and in the end carbonated hydrogen gas. The coaly matter in the retort contains potaſh, muriate of potaſh, phoſphate of lime, and ſometimes muriate of ſoda, with a ſmall portion of magneſia and iron.

The conſtituent parts which enter into the compoſition of milk, are the following:

2717 Compoſition.

1. Water,
2. Oil,
3. Curd,
4. Gelatine,
5. Sugar of milk,
6. Muriate of ſoda,
7. Muriate of potaſh,
8. Phoſphate of lime,
9. Sulphur.

2718 Milk different in different animals. 11. Although the milk of different animals be compoſed nearly of the ſame ſubſtances, the proportions vary ſo much, as to give them very different properties.

2719 Compared. The following are the reſults of the inveſtigations of Deyeux and Parmentier with regard to the properties of the component parts of the milk of different animals compared together.

A. Every kind of milk when left at reſt, produces cream on the ſurface, but it is different in the milk of different animals.

a. In the milk of the cow it is copious, thick, and of a yellow colour.

b. In women's milk it is more liquid, white, and in ſmall quantity.

c. In goats milk it is more abundant than in that of the cow, thicker and whiter.

d. In ewes milk it is nearly as abundant, and of the ſame colour as that of the cow, but has a peculiar taſte.

e. In aſſes milk it is thick, leſs abundant, and in a great meaſure reſembles that of women's milk.

f. In mares milk it is very fluid, and ſimilar in colour and conſiſtence to good cows milk before the cream appears on the ſurface.

2720 Butter. B. Butter obtained from the milk of different animals, has the following comparative properties.

a. That of the cow is ſometimes of a deep yellow, ſometimes pale or white, and has always a conſiderable conſiſtency.

b. It is difficult to ſeparate the butter from the cream of women's milk. It is in ſmall quantity, inſipid, and of a pale yellow. It has been erroneouſly ſuppoſed that no butter could be obtained from this milk.

c. The butter of aſſes milk is always very white, ſoft, and readily diſpoſed to become rancid.

d. The butter from goats milk is eaſily ſeparated from the cream. It is abundant, always white, ſoft, and diſpoſed to become rancid.

e. The butter from ewes milk is of a yellow colour, ſoft, and ſoon becomes rancid.

f. The butter of mares milk is difficult to be obtained and in ſmall quantity. It has little conſiſtence, and is readily decompoſed.

2721 Curd. C. The curd of milk varies in different animals.

a. That from the milk of the cow is bulky, tremulous, and retains a great deal of the ſerum.

b. That from women's milk is in ſmall quantity, little coherent, has an unctuous feel, and retains but a ſmall portion of the whey.

c. The curd of aſſes milk is ſimilar to the former, but without being unctuous.

d. Curd from the milk of the goat is in great proportion, of a firmer conſiſtence than that of the cow, and retains leſs whey.

e. Curd from ewes milk is fat, viſcid, and communicates a ſoft paſte to cheeſe.

f. The curd from mares milk is in very ſmall quantity, and ſimilar to that from women's milk.

2722 Whey. D. The ſerum or whey conſtitutes a very great proportion of the milk, and exhibits the following varieties.

a. Whey from the milk of the cow is of a greeniſh-yellow colour, a ſweet taſte, and contains ſugar of milk and neutral ſalts.

b. The whey from women's milk has little colour, but has a very ſweet taſte, containing a conſiderable proportion of ſaccharine matter.

c. The whey of aſſes milk is colourleſs, and contains leſs ſalts and more ſugar than that of the cow.

d. Whey of the goat is of a ſlight yellow colour, and contains very little ſugar and ſaline matter. The latter conſiſts almoſt entirely of muriate of lime.

e. The whey of ewes milk is always colourleſs, and contains the ſmalleſt quantity of ſugar, and but a ſmall portion of muriate and phoſphate of lime.

f. The whey of mares milk has little colour, and contains a great proportion of ſaccharine matter and of ſaline ſubſtances *.

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* *Fourcroy*, ix. 435.

V. Of Saliva.

2723 Properties. 1. The ſaliva which is ſecreted by peculiar glands, and which flows into the mouth, is a clear, viſcid fluid, without taſte or ſmell. Its ſpecific gravity varies from 1.0167 to 1.080. It has generally a frothy appearance, being mixed with a quantity of air.

2724 Combines with oxygen. 2. Saliva has a ſtrong attraction for oxygen, which by trituration it communicates to ſome metallic ſubſtances, as mercury, gold, and ſilver. When ſaliva is boiled in water, albumen is precipitated, and when it is ſlowly evaporated, muriate of ſoda is obtained. A vegetable gluten remains behind, which burns with the odour of pruſſic acid.

2725 Action of acids, &c. 3. Saliva becomes thick by the action of acids. Oxalic acid precipitates lime. Saliva is alſo inſpiſſated by alcohol. It is decompoſed by the alkalies; and the nitrates of lead, of mercury, and of ſilver, precipitate muriatic and phoſphoric acids.

2726 Diſtillation. 4. By diſtillation in a retort, it froths up, affords near four-fifths of its quantity of water nearly pure, a little carbonate of ammonia, ſome oil, and an acid. What remains behind conſiſts of muriate of ſoda, phoſphate of ſoda and of lime. The conſtituent parts of ſaliva are the following.

2727 Compoſition.

1. Water.
2. Mucilage.
3. Albumen.
4. Muriate of ſoda.
5. Phoſphate of ſoda.
6. Phoſphate of lime.
7. Phoſphate of ammonia.

2728 Saliva of the horſe. 5. The ſaliva of the horſe is of a greeniſh yellow colour, a diſagreeable ſmell, a ſaline taſte, and ſoapy feel. It is coagulated by the acids, alcohol, and boiling water. A black earthy reſiduum remains after ſpontaneous evaporation. By diſtillation it yields an inſipid watery liquid, carbonate of ammonia, carbonated hydrogen and carbonic acid gaſes, and a black empyreumatic oil.

2729 Pancreatic juice. 6. The pancreatic juice, it is ſuppoſed, poſſeſſes properties analogous to thoſe of ſaliva, and is deſtined for ſimilar purpoſes, namely, to contribute to the ſolution of alimentary ſubſtances, and to their converſion into chyme; but very little is known of its nature and uſes.

VI. Of the Humours of the Eye.

2730 Parts of the eye. 1. The eye is compoſed of three ſubſtances which in anatomy have received the name of humours. Theſe are the aqueous, the vitreous, and the cryſtalline humours or lens. The following obſervations are from Mr Chenevix's experiments on this ſubject *.

2731 Eyes of ſheep. 2. The aqueous humour of the eye of the ſheep is tranſparent like water, and has ſcarcely any taſte or ſmell. The ſpecific gravity is 1.0090. It evaporates ſlowly when expoſed to the air; a coagulum is formed by boiling. When 100 parts are evaporated to dryneſs, eight parts remain behind. None of the metallic ſalts produce any precipitate except nitrate of ſilver, which throws down the muriate of ſilver. Tan alſo produces a precipitate in the aqueous humour. The component parts, therefore, of this ſubſtance, are albumen, gelatine, and muriatic acid, or rather muriate of ſoda, as the acid is in combination with ſoda. The vitreous humour exhibited the ſame properties.

3. The cryſtalline lens of the ſheep is ſolid, compoſed of concentric coats, and tranſparent. The ſpecific gravity is 1.1. It has ſcarcely any taſte when it is freſh. It is ſoluble in water, and the ſolution is coagulated by heat. Tan produces a copious precipitate, both before and after coagulation. Its component parts are, therefore, albumen and gelatine, with water.

2732 Human eye. 4. The human eye was found to be compoſed of the ſame ſubſtances. The ſpecific gravity of the aqueous and vitreous humours is 1.0053; of the cryſtalline lens, 1.0790. The ſpecific gravity of the aqueous and vitreous humours of the eye of the ox is 1.008; the cryſtalline lens 1.0765. The compoſition is the ſame as that of the ſheep.

VII. Of Tears and Mucus.

2733 Properties. 1. The tears are ſecreted by the lachrymal gland, for the purpoſe of lubricating the eye. This liquid is tranſparent and colourleſs, has no perceptible ſmell, but a ſaline taſte. It communicates to vegetable blues a permanent green colour. When it is evaporated nearly to dryneſs, cubic cryſtals are formed, which are muriate of ſoda. Soda is in exceſs, becauſe vegetable blues are converted by it to a green colour. A portion of mucilaginous matter, which becomes yellow as it dries, remains after the evaporation. This liquid is ſoluble in water and in alkalies. Alcohol produces a white flaky precipitate, and when it is evaporated muriate of ſoda and ſoda remain behind. By burning the reſiduum, ſome traces of phoſphate of lime and of ſoda are detected. The component parts of tears, are, therefore,

2734 Compoſition.

Water,
Mucilage,
Soda,
Muriate of ſoda,
Phoſphate of lime,
Phoſphate of ſoda.

The mucilage of tears abſorbs oxygen from the atmoſphere, and becomes thick, viſcid, and of a yellow colour. It is then inſoluble in water. Oxymuriatic acid produces a ſimilar effect. It is converted into muriatic acid, ſo that it has been deprived of its oxygen.

2735 Mucus. 2. The mucus of the noſe conſiſts of the ſame ſubſtances as the tears; but being more expoſed to the air, it acquires a greater degree of viſcidity from the mucilage abſorbing oxygen.

VIII. Of the Wax of the Ear.

2736 Properties. 1. The wax of the ear, or *cerumen*, is a liquid ſecreted by glands, which are ſituated in the internal ear. It is of a viſcid yellow colour, and becomes concrete by expoſure to the air. The taſte is bitter; it melts with a moderate heat, gives out an aromatic ſmell, and ſtains paper like oil. When thrown upon burning coals, it gives out a white ſmoke, melts, ſwells, becomes dark-coloured, and gives out the odour of ammonia. A light coaly matter remains behind. It forms a kind of emulſion by agitation with water.

2737 Action of alcohol. 2. Alcohol diſſolves a portion of cerumen; the undiſſolved part exhibits the properties of albumen mixed with oil. By evaporating the alcohol, an orange-coloured reſiduum, ſimilar to turpentine, is left behind. It has the properties of reſin of bile. This matter is alſo ſoluble ſuble in ether. By burning the albumen of the cerumen, ſome traces of ſoda and phoſphate of lime are detected. The component parts of cerumen are,

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* *Phil. Tranſ.* 1802.

2738 Compoſition.

Albumen,
Reſin,
Colouring matter,
Soda,
Phoſphate of lime.

IX. Of Synovia.

2739 Properties. 1. The liquid ſecreted within the capſular ligaments of the joints, to facilitate motion by lubricating theſe parts, is called *ſynovia*. The ſynovia of the ox is a viſcid, ſemitranſparent fluid, of a greeniſh-white colour, which ſoon acquires the conſiſtence of jelly, and not long after becomes again fluid, depoſiting a filamentous matter.

2740 Action of water. 2. Synovia mixes with water, and renders it viſcid. When this mixture is boiled, it becomes milky, and ſome pellicles are depoſited on the ſides of the veſſel. Alcohol produces a precipitate when added to ſynovia. This precipitate is albumen. After this matter is ſeparated, the liquid ſtill remains viſcid; but if acetic acid be added, the viſcidity diſappears, and it becomes tranſparent, depoſiting a white filamentous ſubſtance, which reſembles vegetable gluten. It is ſoluble in cold water, and in concentrated acids and pure alkalies. This fibrous matter is precipitated by acids and alcohol in flakes.

2741 Acids. 3. The concentrated mineral acids produce a flaky precipitate, which is ſoon rediſſolved; but the viſcidity of the liquid is not deſtroyed till they are ſo much diluted with water, that the acid taſte is only perceptible.

2742 Salts ſeparated. 4. When ſynovia is expoſed to dry air, it evaporates, and cubic cryſtals remain in the reſiduum with a white ſaline efflореſcence. The firſt are muriate of ſoda, and the latter carbonate of ſoda. This ſubſtance ſoon becomes putrid, giving out ammonia during its decompoſition. By diſtillation in a retort, it yields water, which ſoon becomes putrid; water containing a portion of ammonia, and an empyreumatic oil, with carbonate of ammonia; by waſhing the reſiduum, muriate and carbonate of ſoda may be obtained. A ſmall portion of phoſphate of lime is found in the coaly matter. The conſtituent parts of ſynovia are the following:

2743 Compoſition.

Fibrous matter	11.86
Albumen	4.52
Muriate of ſoda	1.75
Soda	00.71
Phoſphate of lime	00.70
Water	80.46
	100.00*

X. Of Semen.

2744 Properties. 1. Semen is ſecreted in the teſtes of male animals: but when it is ejected it is compoſed of two ſubſtances; the one is fluid and milky, and the other of a thick mucilaginous conſiſtence, in which appear a great number of white ſilky filaments, eſpecially if it be agitated in cold water. It has a diſagreeable odour, and an acrid irritating taſte. The ſpecific gravity varies conſiderably, but is always greater than that of water. When it is rubbed in a mortar, it froths up, and acquires the conſiſtence of pomatum from the air with which it mixes. It converts the flowers of mallow and of violets to a green colour, and it precipitates the calcareous and metallic ſalts; which ſhews, that it contains an uncombined alkali. The thick part of the ſemen as it cools, becomes tranſparent, and aſſumes a greater degree of conſiſtence; but it afterwards becomes entirely liquid, even without abſorbing moiſture from the air. This change takes place in about twenty minutes from the time of its emiſſion.

2745 Action of air. 2. If ſemen be expoſed to the air after it has become liquid at the temperature of 60°, it becomes covered with a tranſparent pellicle, and at the end of three or four days depoſits fine tranſparent cryſtals of a line in length, croſſing each other like radii from a center. When they are magnified, they appear to be four-ſided priſms terminated by long four-ſided pyramids. When ſemen is expoſed to a warm air, in conſiderable quantity, it is decompoſed; it aſſumes the colour of the yolk of egg, and becomes acid, either by abſorbing the oxygen from the atmoſphere, or by a different combination and arrangement of its own conſtituent principles. It then emits the odour of putrid fiſh, and is covered with the *byſſus ſeptica*.

2746 Of heat. 3. Heat accelerates the liquefaction of ſemen; and when it has undergone this change it is no longer ſuſceptible of coagulation. It is decompoſed by the application of ſtrong heat. Water is firſt ſeparated; it then blackens, ſwells up, and emits yellow fumes, having an empyreumatic, ammoniacal odour. A light coal remains behind, which burns readily to white aſhes.

2747 Of water. 4. Before it has become fluid, ſemen is not ſoluble in water either cold or hot. To the latter it communicates an opal colour. But in the fluid ſtate it combines readily with either hot or cold water, from which it is ſeparated by alcohol or oxymuriatic acid in the form of white flakes. The alkalies promote the ſolution of ſemen in water.

2748 Of lime. 5. No ammonia is diſengaged from freſh ſemen by means of quicklime; but when it has been expoſed for ſome time to a warm and moiſt air, it is ſeparated in great abundance, ſo that ammonia is formed during its expoſure to the air.

2749 Acids. 6. The acids readily diſſolve ſemen, and this ſolution is not decompoſed by the alkalies; nor indeed is the alkaline ſolution of ſemen decompoſed by the acids. Wine, cyder, and urine alſo diſſolve ſemen, but it is in conſequence of the acid which is combined with theſe liquids. Water acidulated with ſulphuric acid acquires the ſame property. Oxymuriatic acid coagulates ſemen in white flakes which are inſoluble in water and in acids. The ſame acid produces the coagulation of fluid ſemen. This is owing to the abſorption of oxygen derived from the acid which is converted into muriatic acid.

2750 Salts. 7. Barytic ſalts are not decompoſed by the ſeminal fluid which has been liquefied in a cloſe veſſel; but when it has undergone this change in the open air, rhomboidal cryſtals are formed with the addition of theſe ſalts. The calcareous and metallic ſalts are decompoſed by ſemen in both conditions. From theſe facts it appears that ſemen contains an uncombined alkali, which has not the property of decompoſing the barytic ſalts till it has combined with the carbonic acid from the atmoſphere.

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* Annal. de Chim. xiv. p. 123.

2751 Semen contains phoſphate of lime.

8. The cryſtals which form in ſemen by ſpontaneous evaporation in the open air, and which are entangled in the viſcid matter, may be ſeparated by adding water. Theſe cryſtals have neither ſmell nor taſte. They melt under the blow-pipe into a white opake globule which is ſurrounded with a yellowiſh flame. This ſalt is inſoluble in water, and is not acted on by the alkalies; but is ſoluble in the mineral acids without effervefcence, from which ſolutions, lime water, the alkalies, and oxalic acid, throw down a precipitate. Alcohol added to the concentrated muriatic ſolution of this ſubſtance, diſſolves part of it, which exhibits all the characters of muriate of lime; and there remains another ſubſtance which melts under the blow-pipe into a green tranſparent glaſs ſoluble in water, which precipitates lime water and reddens vegetable blues. This ſalt, therefore, as is demonſtrated from theſe experiments, is phoſphate of lime. After the formation of the above ſalts, a great number of ſmall, white, opake bodies appear on the ſurface. They are alſo phoſphate of lime.

2752 And ſoda.

9. By burning 40 grains of dried ſemen in a crucible, it firſt became ſoft, and then gave out the odour of burnt horn accompanied with yellow fumes. It blackened and emitted the odour of ammonia. The coaly matter which remained was lixiviated with water. This was evaporated, and afforded cryſtals in the form of rhomboidal plates, which effervefced with acids; with ſulphuric acid afforded ſulphate of ſoda, and with muriatic acid formed muriate of ſoda. The alkali, therefore, was ſoda.

10. The alkaline matter being ſeparated, the reſiduum was ſtill expoſed to ſtrong heat, and furniſhed 13 grs. of white aſhes which had the following properties. By the action of the blow-pipe it is converted into an opake white enamel which attracts moiſture from the air, is ſoluble in acids, and the ſolution has all the characters of phoſphate of lime. The component parts of ſemen therefore are

2753 Compoſition.

Water	90
Mucilage	6
Soda	1
Phoſphate of lime	3
	100*.

XI. Of the Liquor of the Amnios.

1. This liquid is ſecreted in the *amnios* or bag which ſurrounds the fœtus in the uterus. It is very different in different animals, ſo far at leaſt as its nature and properties have been inveſtigated. The liquor of the amnios of women and cows only has been examined. The following are the reſults of the experiments of Vauquelin and Buniva on theſe liquids *.

2754 Properties.

2. This liquid in women is of a milky colour, an agreeable odour and a ſaline taſte. It becomes tranſparent by filtering and ſeparating ſome coagulated matter which is ſuſpended in it, and which communicates the white colour. The ſpecific gravity is 1.005. It ſeems to contain both an acid and an alkali; for it converts ſyrup of violets to a green colour, and reddens the tincture of turnſole. It froths when agitated, becomes opaque when heated, and exhales the odour of the white of egg.

2755 Action of heat.

2756 Acids.

3. It is rendered more tranſparent by acids; but alcohol and the alkalies occaſion a flaky precipitate, which is like glue when it is dried. The infuſion of nut-galls gives a copious brown precipitate; and nitrate of ſilver produces a white precipitate, which being inſoluble in nitric acid, is muriate of ſilver.

4. By ſlow evaporation this liquid aſſumes a milky appearance; a tranſparent pellicle forms on the ſurface, and a very ſmall reſiduum is left. By adding water to the reſiduum, and evaporating the ſolution, muriate and carbonate of ſoda are obtained. The aſhes which remain, after burning the reſiduum, conſiſt of carbonate of ſoda, phoſphate and carbonate of lime. During the burning a ſtrong, fetid, ammoniacal odour is exhaled.

2757 Compoſition.

5. From theſe experiments, it appears that this liquid conſiſts of a great proportion of water, of albumen, muriate of ſoda, of ſoda, phoſphate of lime, and lime.

2758 Cruſt on the fœtus.

6. A white ſhining ſoft ſubſtance, ſomewhat reſembling ſoap, is depoſited on the body of the fœtus in the uterus. It is inſoluble in water, alcohol, and oils. The cauſtic alkalies diſſolve a portion of it, and form a kind of ſoap. It decrepitates on burning coals, then dries, blackens, and gives out the odour of an empyreumatic oil. It leaves behind a coaly matter, which burns with difficulty. When it is heated in a crucible of platina, it decrepitates, while an oily matter exudes. It then curls up like horn, inflames, and leaves behind gray aſhes, which efferveſce with acids, and which ſeem to be compoſed chiefly of carbonate of lime.

2759 Compoſition.

7. This matter ſeems to be a mixture of animal mucilage and fat, originating from the albumen, which has undergone ſome peculiar change. The parts of a fœtus which have remained in the uterus after death, have been found converted into a fatty matter.

2760 Characters.

Liquor of the amnios of the cow.—1. This liquid differs from the former in being of a reddiſh brown colour, in having an acid bitter taſte, an odour reſembling the extracts of ſome vegetables, and the viſcidity of a ſolution of gum. The ſpecific gravity is 1.028. It reddens the tincture of turnſole, forms a copious precipitate with muriate of barytes, and with alcohol a precipitate of a reddiſh matter.

2761 Amniotic acid.

2. When it is evaporated, a thick ſcum forms on the ſurface, which is eaſily ſeparated, and which, on cooling, is found to contain white cryſtals of a ſlightly acid taſte. A viſcid matter like honey appears, by continuing the evaporation. When this matter is treated with boiling alcohol, it furniſhes, on cooling, an acid which cryſtallizes in ſhining needles. This is the *amniotic acid* which has been already deſcribed. The matter which remains after the ſeparation of the cryſtals is inſoluble in alcohol, and is firm and tenacious.

2762 Sulphate of ſoda obtained.

3. Having extracted the whole of the acid, if the evaporation be continued till the liquid acquire the conſiſtence of a ſyrup, large tranſparent cryſtals are formed, which have a bitter taſte, and are ſoluble in water. Theſe cryſtals were found to be ſulphate of ſoda,

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* *Vauquelin, Ann. de Chim.* ix. 64—80.

* *Ann de Chim.* xxxiii. 269.

ſoda, which are obtained in a ſtate of purity, by burning the reſiduum of a quantity of the liquid evaporated to dryneſs, diſſolving the coaly reſiduum in water, and evaporating.

2763 Animal matter. 4. The animal matter which accompanies the ſaline ſubſtances, is of a reddiſh brown colour and a peculiar taſte, very ſoluble in water, but inſoluble in alcohol, which even ſeparates it from water. It neither combines with tan, nor is it ſuſceptible of being converted into jelly, ſo that it does not poſſeſs the properties of animal mucilage. When it is heated ſtrongly, it ſwells up, exhales, at firſt the odour of burning mucilage; afterwards that of ammonia and an empyreumatic oil; and, at laſt, that of pruſſic acid. When it is burnt, there remains behind a bulky coal, the aſhes of which are white, and contain phoſphate of magneſia and a ſmall portion of phoſphate of lime.

2764 Compoſition. 5. The conſtituent parts of the liquor of the amnios of the cow, are the following.

Water,
Acid,
Sulphate of ſoda,
Animal matter.

XII. Of Fluid Morbid Secretions.

1. During the diſeaſed action of the veſſels of different parts of the body, liquids are ſecreted, as, for inſtance, when the muſcular or bony parts are wounded, a matter is exuded, which continues to flow till the wound is healed up; in dropſical diſeaſes a liquid is ſecreted in the different cavities of the body; and when the ſkin is irritated by the action of bliſters, a fluid collects between the cuticle and true ſkin.

Liquor of dropſy.—This liquid is of a yellowiſh green colour, has ſometimes conſiderable tranſparency, but is ſometimes turbid. In its chemical properties it ſeems to correſpond with the ſerum of the blood.

Liquor of bliſters.—The liquor which is ſecreted by the action of bliſters is uſually tranſparent. The conſtituent parts are the ſame as thoſe of the ſerum of the blood. Two hundred parts of this liquid yielded

Albumen,	36
Muriate of ſoda,	4
Carbonate of ſoda,	2
Phoſphate of lime,	2
Water,	156
	200 *

Pus.—What is called healthy pus is about the conſiſtence of cream, and of a yellowiſh-white colour, an inſipid taſte, and when it is cold, without ſmell. It produces no change on vegetable blues.

2765 Action of heat. 2. When pus is expoſed to a moderate heat, it dries, and aſſumes the appearance of horn. By diſtillation it gives out water in conſiderable proportion, ammonia and ſome gaſeous ſubſtance and an empyrematic oil; a ſhining coaly matter remains behind, the aſhes of which, after being burnt, afford ſome traces of iron.

2766 Of air and acids. 3. When this liquid is expoſed to the air, it becomes acid. It is ſoluble in ſulphuric acid, forming with it a purple-coloured ſolution. With the addition of water the pus ſeparates, and the dark colour diſappears. With concentrated nitric acid it forms a yellow coloured ſolution, which effervesces during the combination. Water produces a precipitate. Pus is alſo ſoluble in muriatic acid, and is ſeparated by means of water. Pus is not ſoluble in alcohol, but is thickened; nor is it ſoluble in the oils.

2767 Alkalies. 4. A whitiſh ropy fluid is formed by the addition of a ſolution of the fixed alkalies, and by adding water the pus is precipitated. Pure ammonia forms with pus a tranſparent jelly, and diſſolves it in conſiderable proportion.

2768 Metallic ſalts. 5. A precipitate is occaſioned by means of nitrate of ſilver, and it is ſtill more copious with nitrate and oxymuriate of mercury.

2769 To diſtinguiſh pus. 6. The following teſts have been given to diſtinguiſh pus from mucus, which is of conſiderable importance in caſes where the formation of pus is ſuſpected in the lungs.

1. Pus is ſoluble in ſulphuric acid, and precipitated by water. Mucus ſwims. 2. Pus may be diffuſed through water, diluted ſulphuric acid; and brine; but mucus is not. 3. Pus is ſoluble in alkaline ſolutions, and is precipitated by water; but this is not the caſe with mucus.

2770 Varies in its properties. 7. Theſe are the properties of pus when it is ſecreted from a ſore which is ſaid to be in good condition, or in a diſpoſition to heal. Its properties are very different in what are called ill-conditioned ſores. In theſe caſes the matter ſecreted is thin, fetid, and acrid. Matter ſecreted by cancerous ſores, which has been examined, converts the ſyrup of violets to a green colour, and from this matter ſulphurated hydrogen gas is ſeparated by means of ſulphuric acid. This gas is ſuppoſed to exiſt in combination with ammonia.

Subdiviſion III. Of the Solid Parts of Animals.

2771 Enumeration. The following are the ſolid parts of animal, which we ſhall treat of in the order in which they are enumerated.

1. Bones,
2. Skin,
3. Muſcles,
4. Cartilage, tendons, &c.
5. Brain and nerves,
6. Hair and nails,
7. Morbid concretions.

I. Of the Bones.

2772 Of different denſity. 1. The bones are thoſe parts of animals which give firmneſs, ſtrength, and ſhape to the body. Bones are very different with regard to ſolidity and denſity, not only in different parts of the body, but even in the ſame bone. The ſpecific gravity, therefore, of bones, muſt be various. They are of a white colour, of a lamellated ſtructure, and inflexible.

2773 Action of heat. 2. When bones are burnt, they are converted into a white, porous, inſipid ſubſtance, which ſtill retains the ſhape of the bone.

2774 Contains fat. 3. When bones are broken into ſmall pieces, and boiled in water, a conſiderable quantity of fat riſes to the ſurface; an oily matter, therefore, is one of the conſtituent parts of bones.

2775 Gelatine. 4. If the boiling be continued for a greater length of time, the water diſſolves another ſubſtance, which, being concentrated and left at reſt, aſſumes a gelatinous form. Bones, therefore, contain a portion of gelatine.

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* Ann. de Chim. xiv. 225.

2776 Cartilage. 5. If bone is kept for ſome time in diluted muriatic acid, it is converted into a white flexible ſubſtance, which retains the ſhape of the bone. It becomes brittle and ſemitranſparent when dried; it is ſoluble in nitric acid, and when this acid is diluted, it is converted by its action into gelatine. It forms a ſoap with the fixed alkalies. From theſe properties it reſembles coagulated albumen. This ſubſtance, which is called cartilage, is the firſt part of the bone which is formed.

2777 Salts. 6. Beſides theſe ſubſtances, bones contain a conſiderable proportion of earthy ſalts. Theſe are phoſphate of lime, which is in great proportion; carbonate of lime in ſmaller proportion, with a ſtill ſmaller of ſulphate of lime.

2778 Compoſition. 7. The component parts of bones, therefore, are earthy ſalts, cartilage, gelatine, and fat. The following table exhibits the proportion of theſe conſtituent parts in the bones of different animals. It was drawn up by Merat-Guillot. A hundred parts of bone were employed, and as much dried as poſſible, and to this quantity the proportions ſpecified refer *.

Names.	Gelatine.	Phoſphate of lime.	Carbonate of lime.	Loſs.
Human bones taken from a burying ground.	16.	67	1.5	15.5
Human bones dried but not buried.	23.	63	2	2
Bones of the ox	3.	93	2	2
——— calf	25.	54	—	21
——— horſe	9.	67.5	1.25	22.25
——— ſheep	16.	70.0	0.5	13.5
——— elk	1.5	90.0	1.0	7.5
——— hog	17.82	52.0	1.0	30.0
——— hare	9.0	80.5	1.0	5.0
——— pullet	6.0	72.0	1.5	20.5
——— pike	12.0	64.0	1.0	23.0
——— carp	6.0	45.0	0.5	28.5

2779 Of teeth. 8. The human teeth have been analyzed by Mr Pepys, and he found the conſtituents of different teeth, and different parts of the teeth, to be the following.

	Teeth of adults.	Shedding teeth of children.	Roots of the teeth.
Phoſphate of lime	64	62	58
Carbonate of lime	6	6	4
Cartilage	20	20	28
Loſs	10	12	10
	100	100	100

He found the following to be the component parts of the enamel of the teeth.

Phoſphate of lime	78
Carbonate of lime	6
Loſs and water	16
	100

But according to Fourcroy and Vauquelin the enamel is compoſed of

Phoſphate of lime	72.9
Gelatine and water	27.1
	100.0

II. Of the Skin.

2780 Conſiſts of three parts. 1. The ſkin, which forms the external covering of animals, conſiſts of three parts; the epidermis or cuticle, the true ſkin, and a ſoft ſubſtance called the *rete mucoſum*, which lies between the cuticle and true ſkin.

2781 Epidermis. 2. The epidermis, which may be ſeparated from the cutis, by macerating the ſkin in hot water, is a thin elaſtic ſubſtance, which is inſoluble in water and in alcohol.

2782 Action of acids, &c. 3. Sulphuric and muriatic acids have little action for ſome time on this ſubſtance; but it is immediately converted into a yellow colour by means of nitric acid, and at laſt entirely decompoſed. It is entirely ſoluble in the cauſtic fixed alkalies. From theſe properties the epidermis is ſuppoſed to be coagulated albumen in a peculiar ſtate of modification.

2783 Cutis. 4. The cutis or true ſkin is denſer and thicker. When it is heated, it firſt contracts, then ſwells, exhaling a fetid odour, and leaving behind a denſe maſs of charcoal. By diſtillation the ſame products are obtained as from fibrina.

2784 Action of heat. 5. The ſkin is ſoftened by weak acids, is rendered tranſparent, and is at laſt diſſolved. It is converted into oxalic acid and fat by nitric acid, with the evolution of azotic gas and pruſſic acid. It is converted by means of the concentrated alkalies into oil and ammonia.

2785 Contains gelatine. 6. After maceration for ſome time in water, a ſmall proportion of gelatine may be obtained, by evaporating the water; but if the ſkin be boiled for a conſiderable time in water, it is entirely diſſolved, and the liquid, by evaporation, aſſumes the conſiſtence of jelly. The ſkin is thus converted into glue. It is from the ſkin of animals that glue is chiefly extracted; and it is obtained of different degrees of ſtrength from the ſkin of different animals.

2786 Tanning. 7. As ſkin conſiſts chiefly of gelatine, it combines readily with tan. This compound forms leather; and the proceſs by which it is effected is called *tanning*, for the detail of which ſee the article TANNING.

2787 Rete mucoſum. 8. The mucous ſubſtance, or *rete mucoſum*, lies between the epidermis and true ſkin. It is this which gives the black colour to the ſkins of negroes. It is deprived of its colour, even in the living body, by means of oxymuriatic acid. The foot of a negro became nearly white by being kept for ſome time in water impregnated with this acid. The black colour, however returned in a few days.

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* *Ann. de Chim.* xxiv. 71.

III. Of the Muſcles.

1. The muſcular, or fleſhy parts of animals, are of a reddiſh-white colour, and fibrous ſtructure. If a
2788 Structure. quantity of muſcular ſubſtance is ſeparated into ſmall pieces, it becomes white. If the water be heated,
2789 Action of cold water. it coagulates. Albumen and a portion of fibrina are obtained. It becomes gelatinous by farther evaporation; and, when the proceſs is carried on to dryneſs, and alcohol added, a peculiar matter is diſſolved; which, after the alcohol is expelled by heat, appears of a reddiſh-brown colour, has an aromatic ſmell, and a very acrid taſte; and it is ſoluble both in water and alcohol. The gelatine formed in the maſs evaporated to dryneſs, with a little phoſphate of ſoda and ammonia, remains undiſſolved by the alcohol. When this extractive matter is diſtilled, it affords an acid, which is combined with ammonia.

2790. Boiling. By boiling the ſame muſcular matter for ſome time in water, another portion of albumen is obtained; and, when the water is concentrated by evaporation, it is converted into a jelly; and by treating with alcohol as before, after evaporating to dryneſs, the extractive matter is taken up, and the gelatine and phoſphoric ſalts remain undiſſolved. The fibres of the muſcle are then of a gray colour, inſoluble in water, and become brittle when dry. This ſubſtance is fibrina, which conſtitutes the chief part of muſcular matter.

2791. Nitric acid. 2. If muſcular matter be diſſolved in nitric acid, and ammonia added to the ſolution, a precipitate of phoſphate of lime is obtained; but no phoſphate of lime is obtained, when treated in this way, after being long boiled in water, for it is either combined with the gelatine, or is thus rendered ſoluble. Carbonate of lime, however, is found after boiling the muſcular ſubſtance, and is converted into oxalate of lime by means of nitric acid.

2792. Compoſition. 3. The conſtituent parts of muſcular matter are the following:

Fibrina,
Albumen,
Gelatine,
Extractive,

Phoſphate of ſoda,
Phoſphate of ammonia,
Phoſphate of lime,
Carbonate of lime.

2793 Properties of muſcular matter for food. 4. From the difference of ſolubility of the ſubſtances which enter into the compoſition of muſcular matter, and the different effects of heat on theſe ſubſtances, the ſenſible qualities at leaſt muſt vary conſiderably, according to the manner in which this matter is
2794 Boiled. prepared for food. Accordingly, when the fleſh of animals is boiled, thoſe parts which are ſoluble in water, combine with it. Theſe are, the gelatine, the extractive matter, and part of the ſaline bodies. It is to theſe that the nutritious property of ſoups is aſcribed.
2795 Roaſted. But when the fleſh of animals is roaſted, it has a much higher flavour, in conſequence of theſe ſubſtances not being ſeparated from it, and particularly the extractive matter, on which the odour and flavour depend. This extractive matter, according to Fourcroy, compoſes the brown cruſt which is formed on fleſh during its roaſting.

2796 Different properties. 5. The muſcular part of different animals, from its ſenſible qualities at leaſt, ſeems to poſſeſs very different properties. Hence the difference in the taſte, flavour and nutritious quality, of the fleſh of different animals.

2797 The Converſion of muſcular matter into ſpermaceti. 6. When the muſcular parts of animals are expoſed for a conſiderable length of time to the action of running water, they are converted into a peculiar ſubſtance, reſembling in ſome meaſure ſpermaceti. The ſame change indeed, in ſimilar circumſtances, takes place on the other ſoft parts of animals. This was firſt obſerved in the year 1786, in the Innocents burying-ground in Paris, where great numbers of bodies were thrown together into the ſame pit. The time which was required for this converſion was ſuppoſed to be in general about thirty years. But it has ſince been found, that animal matters are converted into a ſubſtance exactly ſimilar, and in a much ſhorter period, by expoſing them to the action of running water.

2798. Properties. 7. The matter produced by this change is of a white colour, ſoft and unctuous to the feel, and melts like tallow. It is decompoſed by diluted acids, and an oily matter, with which it is mixed, is ſeparated. By the action of alkalies and lime, ammonia is evolved. By expoſure to the air, it is deprived of its white colour; the ammonia is almoſt entirely carried off, and a ſubſtance reſembling wax remains behind. The oily matter which is ſeparated by a diluted acid, is of a white colour and concrete. It becomes of a grayiſh brown colour by drying, and aſſumes a cryſtalline, lamellated texture, like ſpermaceti. At the temperature of 126° it melts. It is ſoluble in alcohol at the temperature of 120°. It forms a ſoap with alkalies, and burns like oil; but exhales a diſagreeable odour, which is the chief objection to its uſe as a ſubſtitute for oil, as it is ſuppoſed it may be obtained at a cheaper rate. A manufacture indeed has been eſtabliſhed at Briſtol for the preparation of this ſubſtance.

IV. Of Membranes, Tendons, and Ligaments.

2799 Membranes. 1. Membranes are thoſe parts of the body which include ſome of the internal parts of animals. Many of them are extremely thin, and they poſſeſs different degrees of tranſparency. They become pulpy by maceration in water, and by boiling are almoſt entirely converted into gelatine, ſo that they are chiefly compoſed of this ſubſtance. No phoſphate of lime or other ſaline matter has been detected in the membranous ſubſtances hitherto analyzed.

2800 Tendons. 2. Tendons are reduced by boiling to a gelatinous ſubſtance, ſo that they are compoſed of a ſimilar matter with membranes.

2801. Ligaments. 3. The ligaments afford a portion of gelatine by boiling, but are not, like the two former, entirely reduced to jelly, ſo that ſome other ſubſtance beſides gelatine enters into the compoſition of ligaments.

V. Of the Brain and Nerves.

2802 Action of water, &c. 1. The matter of the brain and nerves has a ſoft, ſoapy feel, and a cloſe texture. When expoſed to the air at the temperature of 60°, it ſoon becomes putrid, exhaling an offenſive ſmell, and giving out a conſiderable quantity of ammonia. It is not ſoluble in cold water; but triturated with water in a mortar, a part is diſſolved, and if this be heated moderately, it coagulates. If ſulphuric acid be added to this ſolution, white flakes appear on the ſurface, and the liquid aſſumes a red colour. Similar flakes are produced by the action of nitric acid, but the colour of the liquid is yellow. If nitric acid be added till a ſlight acidity is produced, a coagulum of a white colour ſeparates, which is inſoluble in water and alcohol, is ſoftened by heat, and becomes tranſparent when it is dried. This matter, therefore, poſſeſſes many of the properties of albumen.

2803. Sulphuric acid. 2. If a quantity of brain be triturated with diluted ſulphuric acid, part is diſſolved, and part is coagulated. The liquid part is colourleſs, and when it is evaporated, it becomes black, while ſulphurous acid is exhaled, and cryſtals are formed. When it is evaporated to dryneſs, a black maſs remains behind. By diluting this with water, charcoal ſeparates. The matter therefore is entirely decompoſed, ammonia is diſengaged, and combines with the acid, forming ſulphate of ammonia. By evaporting the water, ſulphate of ammonia and ſulphate of lime, phoſphoric acid, and phoſphates of ſoda and ammonia are obtained; and theſe ſalts may be ſeparated by means of alcohol. Theſe ſalts, however, exiſt in brain in ſmall proportion. 2804 Nitric acid. By treating in the ſame way a quantity of brain with nitric acid, part is diſſolved, and part coagulated. When the ſolution, which is tranſparent, is evaporated till the acid is concentrated, carbonic acid and nitrous gaſes are evolved; a great quantity of ammonia is ſeparated with efferveſcence, and charcoal remains behind, mixed with oxalic acid.

2805 Of heat. 3. If a quantity of brain be evaporated to dryneſs with a gentle heat, a portion of tranſparent liquid ſeparates, and the reſiduum aſſumes a brown colour when it is dried. The weight of this reſiduum does not exceed one-fourth of the quantity employed. If the reſiduum be repeatedly boiled with alcohol, more than one-half is diſſolved; and when the alcohol cools, it depoſits a yellowiſh white ſubſtance in the form of ſhining plates, which may be reduced to a kind of ductile paſte. It becomes ſoft with the heat of boiling water, and blackens with an increaſe of temperature, exhaling empyreumatic and ammoniacal fumes; a charred matter remains behind. By evaporating the alcohol, a yellowiſh black matter is depoſited, which reddens paper ſtained with turnſole.

2806 Alkalies. 4. Brain is ſoluble in concentrated cauſtic potaſh; and during the ſolution, a great quantity of ammonia is given out.

VI. Of Hair and Nails.

2807 Different in appearance. 1. If we include all thoſe ſubſtances which form the covering of animals, as briſtle, hair, wool, and down, under the general name of hair, and particularly as they poſſeſs nearly the ſame properties, we ſhall find that it varies greatly in ſize, in length, and colour, in different animals, and even in different parts of the body of the ſame animal.

2808 Action of water. 2. If hair be boiled in water, a quantity of gelatine is obtained, and by continuing the boiling, the hair becomes ſo brittle, that it crumbles to pieces. The part which remains, after the gelatine has been ſeparated, ſeems to be coagulated albumen. But beſides gelatine and albumen, it appears from the combuſtion of hair, that it contains a portion of oily matter. Berthollet obtained by the diſtillation of a quantity of hair, carbonate of ammonia, water having the ſmell of burnt hair, ſome oil, and elaſtic fluids which were probably carbonated hydrogen and carbonic acid gaſes. The oil was of a browniſh colour, and was concrete in the ordinary temperature of the atmoſphere. 2809 Diſtillation. It was ſoluble in alcohol, and burnt with a vivid flame. The charcoal which remained could ſcarcely be calcined, but ſome of its particles were attracted by the magnet.

2810 Acids. 3. The acids ſoften and deſtroy the colour of hair. It is decompoſed by ſulphuric acid with the aſſiſtance of heat; charcoal is depoſited, and carbonic acid gas given out. Nitric acid communicates a yellow colour to hair, and diſſolves it with the aid of heat. An unctuous matter is ſeparated, and oxalic acid is formed. Muriatic acid at firſt whitens hair; but it becomes yellow when it dries. Oxymuriatic acid alſo bleaches hair; but at the ſame time deſtroys its texture. It is converted into a pulp when it is introduced into oxymuriatic acid gas.

2811 Alkalies. 4. Hair is ſoluble in the alkalies, and is converted into a reddiſh-coloured ſoap, with the evolution of ammonia. If muriatic acid be added to the ſolution of hair in potaſh, ſulphurated hydrogen gas is evolved, from which it appears that hair contains ſulphur. Silver is blackened by the ſame ſolution.

2812 Metallic oxides. 5. The metallic oxides alſo have the effect of blackening hair. It is in this way that the hair is dyed black. The red oxide of lead, the acetate of lead, and ſometimes even the nitrate of lead, and the nitrates of mercury and ſilver, are employed for this purpoſe.

2813 Nails. *Nails.*—The nails are conſidered as an elongation of the epidermis. They are attached to it, and ſeparate when it is removed. They become ſoft by long maceration in water. There is no precipitate formed in this ſolution with tan. Nails are ſoluble in the acids and the alkalies. They are ſtained with metallic oxides, and combine with colouring matters. 2814 Compoſition. From theſe properties the nails are conſidered as a kind of coagulated albumen, with a ſmall proportion of phoſphate of lime, and according to ſome, carbonate of lime.

VII. Of Morbid Concretions.

2815 Found in different parts of the body. 1. Earthy matters are frequently found in different parts of animal bodies, which are to be conſidered as extraneous, and occaſioning, at leaſt in the human body, ſome of the ſevereſt diſorders to which it is ſubject. Theſe earthy matters are generally combined with an acid, and in ſome caſes entirely compoſed of an acid. Theſe ſubſtances, which have been called *concretions* and *calculi*, are formed, ſometimes in the ſolid parts of the body, but chiefly among the fluids.

2816 Pineal. *Pineal concretions.*—Theſe concretions are almoſt always found in the pineal gland of the human brain. They are indeed ſo rarely wanting in the brain, that they are conſidered as natural, as they do not ſeem to produce any inconvenience or diſeaſe. They have been found to conſiſt of phoſphate of lime, mixed with ſome animal matter.

2817 Salivary. *Salivary concretions.*—Concretions form in the ſalivary glands, and in the ducts which convey the ſecreted ed fluid from theſe glands to the mouth. The component parts of theſe concretions have been found to be alſo phoſphate of lime and animal mucilage.

2818 Tartar of the teeth. The tartar of the teeth is compoſed of the ſame ſubſtance. When this was examined with the microſcope, it ſeemed to be compoſed of ſmall ſhining grains united to each other, and containing a great number of pores or ſmall angular cavities, reſembling the cells of polypi, on account of which ſome naturaliſts have aſcribed its formation to inſects; but it is more natural to ſuppoſe, that it is a cryſtalline arrangement of the ſaline matter of which it is compoſed.

Concretions have alſo been found in the pancreas, and its ducts, and are ſuppoſed to conſiſt of the ſame materials.

2819 Pulmonary. *Pulmonary concretions.*—Theſe concretions are formed in the lungs during aſthmatic and phthiſical diſorders. They are ſmall hard bodies, unequal and rough, of a gray or reddiſh colour, which become white as they dry in the air. They are alſo compoſed of phoſphate of lime mixed with animal matter.

2820 Inteſtinal. *Inteſtinal concretions.*—Theſe are more rarely met with in the human body. When they are found, they have been generally formed on the ſtones of fruits, or ſome other hard body which has been ſwallowed. They are more frequent in the inteſtines of the inferior animals, as in thoſe of the horſe. Some that have been examined were of a gray colour, and of a radiated or cryſtallized ſtructure. The component parts of a ſtone of this deſcription, analyzed by Berthollet, were

2821 Compoſition. the following.

Magneſia	18.0
Phoſphoric acid	26.0
Ammonia	3.2
Water	46.0
Animal matter	4.0
	97.2*

2822 Biliary compoſed. *Biliary concretions.*—Biliary concretions, or calculi, are formed, either in the liver itſelf, in the gall-bladder or in the gall ducts, hence they have alſo been called *gall-ſtones*. Some found in the liver itſelf, are compoſed of phoſphate of lime combined with ſome animal matter. The calculi which have been found in the gall bladder, are different, both in ſtructure
2823 Of inſpiſſated bile. and compoſition. Some of them ſeem to be compoſed of concentric layers of inſpiſſated bile. Theſe have different degrees of conſiſtence; they are ſometimes friable, and of a brown or reddiſh colour. The gall-ſtones of the ox, which are uſed by painters, are of this kind. Another kind of biliary calculi differ only
2824 Of a ſubſtance like ſpermaceti. from the former in having a ſmooth, whitiſh or grayiſh covering, reſembling ſpermaceti. They are ſometimes found in conſiderable numbers in the gall-bladder.

2825 Of ſhining plates. A third ſpecies is of a white or gray colour, opaque, or ſemitranſparent. Theſe are compoſed of ſhining cryſtalline plates, or have a radiated ſtructure. They are frequently ſolitary, and are then about the ſize, and have the form of a pigeon's egg. The nucleus of this kind of gall-ſtone is compoſed of inſpiſſated bile.

2826 Or mixed. A fourth ſpecies is compoſed of different proportions of the ſpermaceti ſubſtance and the concrete bile. Theſe are the moſt frequent of all the kinds of gall-ſtones, and are alſo the moſt numerous. They are of a deep green or olive colour. Sometimes they exhibit internally, ſmall ſhining plates of a deep yellow colour.

2827 Action of alkalies, &c. All theſe calculi are ſoluble in the cauſtic alkalies, in ſolutions of ſoap, in fixed and volatile oils, in alcohol, and partially in ether.

2828 Urinary calculi. 1. *Urinary concretions.*—Theſe concretions which are frequently formed in the urinary bladder of man, and produce one of the moſt excruciating diſorders to which he is ſubject, have long attracted attention, with a view to prevent their formation, or to effect their diſſolution after they have been formed. Little, however, has yet been done, to accompliſh either of theſe ends; but the nature of the concretions themſelves has been carefully inveſtigated, and their component parts minutely examined by different chemiſts. Among theſe the labours of Fourcroy and Vauquelin
2829 Found in different parts of the organs. are not the leaſt conſpicuous. Urinary calculi are found, either in the kidneys, the ureters, or the urinary bladder itſelf. Calculi, as found in the kidneys, vary conſiderably in ſize, form, colour, and internal ſtructure. They are uſually ſmall, round, concrete bodies, ſmooth and ſhining externally, of a reddiſh-yellow colour, and ſo hard as to be ſuſceptible of a poliſh. They paſs readily along the ureters to the bladder, and from thence are ejected along with the urine. It is the formation of theſe ſmall concretions which conſtitutes the diſeaſe called *gravel*. Some of theſe concretions ſometimes remain in the kidneys, and increaſing in volume by receiving new additions of matter, form large calculi. This happens, however, but rarely. The calculi which have been found in the ureters, have originated from the kidneys, and being too large to paſs along the ureters, receive new additions of matter as it is depoſited from the urine, and enlarge in ſize, at the ſame time dilating the ureter.

But by far the moſt common are thoſe which are found in the bladder itſelf. Theſe calculi have either originated from ſmall concretions formed in the kidneys, and theſe paſſing along the ureters into the bladder, form a nucleus on which ſucceſſive layers of matter are depoſited from the urine; or they have their origin and complete formation in the bladder itſelf, or have been formed on ſome extraneous ſubſtance introduced into the bladder through the urethra. The firſt are the moſt frequent.

2830 Phyſical properties. 2. The form of urinary calculi is various, but they are frequently of a ſpheroidal or egg-ſhape, or compreſſed on two ſides. Sometimes they are polygonal, which happens when there are ſeveral in the bladder at the ſame time. Some have been found of nearly a cubical form. Their extremities are frequently either pointed or obtuſe. Their ſize is extremely various. Sometimes they are not larger than ſmall beans, while ſome have been of ſuch an extraordinary ſize as to fill the bladder itſelf; but they are moſt frequently from the ſize of a pigeon's egg, to that of a hen's egg. Some are of a yellowiſh-brown colour, reſembling wood. Theſe are compoſed of uric acid. Thoſe which are white, or grayiſh-white, conſiſt of the earthy phoſphates, and thoſe which are of a deep gray or blackiſh colour, are compoſed of oxalate of lime. Some exhibit all theſe different ſhades mixed together. The ſurface of urinary calculi is ſometimes ſmooth and poliſhed; ſometimes it is rough and unequal, and tuberculated. Some urinary calculi having their ſurface mamellated, are called *mulberry ſtones*, from ſome reſemblance to a cluſter of mulberries. Some of the white calculi are ſoft and ſmooth, ſemitranſparent, and covered with ſhining cryſtals. The ſpecific gravity varies from 1.213 to 1.976. The odour of urinary calculi is ſometimes perceptibly urinous and ammoniacal, which is diſcovered by raſping or ſawing them; ſometimes it is faint and earthy, as in the white calculi; and ſometimes it reſembles that of ivory ſawed or raſped, and is analogous to the odour of ſemen. Mulberry calculi are diſtinguiſhed by this odour.

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* *Ann. de Chim.* xxiii 130.

2831 Conſtituent parts.

3. The following ſubſtances have been diſcovered in urinary calculi.

Uric acid,
Urate of ammonia,
Phoſphate of lime,
Phoſphate of magneſia and ammonia,
Oxalate of lime,
Carbonate of lime,
Silica,
Animal matter.

2832 Uric acid.

Uric acid exiſts in almoſt all urinary calculi. Many calculi indeed are entirely formed of it; but it is found in greater or ſmaller proportion, in almoſt all that have been analyzed. The nature and properties of this acid have been already deſcribed. The calculi compoſed of it are of a brown colour, are ſmooth and poliſhed, and have the appearance of wood. When this ſubſtance is triturated with a concentrated ſolution of potaſh or ſoda, it forms a thick ſaponaceous matter, which is precipitated by diluted acids. It is diſſolved by nitric acid, and is converted into a red colour. This acid is a compound of azote, carbone, hydrogen, and oxygen; and when decompoſed by chemical agents, it is converted into ammonia, malic, oxalic, pruſſic, and carbonic acids.

2833 Urate of ammonia.

Urate of ammonia, the next ſubſtance found in urinary calculi, is alſo ſoluble in potaſh and ſoda, but the ſolution is accompanied with a copious evolution of ammonia. Calculi compoſed of this ſubſtance, conſiſt of thin layers, and are not always ſmooth. They are generally of a ſmall ſize, and reſemble an infuſion of coffee. The earthy phoſphates are frequently interpoſed between the layers of calculi compoſed of this ſubſtance, and it is often mixed with phoſphate of ammonia and magneſia.

2834 Phoſphate of lime.

Phoſphate of lime frequently enters into the compoſition of calculi. It is uſually in thin layers, which are friable, and have little conſiſtency. They are of a grayiſh-white colour, and opaque, without taſte or ſmell. The phoſphate of lime is uſually mixed with gelatinous matter; is ſoluble in different acids, and is precipitated by the alkalies. Some calculi have been diſcovered entirely compoſed of phoſphate of lime.

2835 Of ammonia.

Phoſphate of ammonia and magneſia is in the form of white, ſemitranſparent layers, and it is ſometimes found cryſtallized on the ſurface of calculi in the form of priſms. When it is reduced to powder it is of a brilliant white, very ſoluble in diluted acids, and is decompoſed by the fixed alkalies.

2836 Oxalate of lime.

Oxalate of lime is uſually mixed with phoſphate of lime and uric acid, but ſometimes it is combined only with animal matter in mulberry calculi. The calculi compoſed of it are of a dark green colour, and extremely hard. It diſſolves with difficulty in diluted nitric acid, and is decompoſed by the carbonates of potaſh and ſoda.

2837 Carbonate of lime.

The carbonate of lime conſtitutes the greateſt part of ſome urinary calculi.

2838 Silica.

Silica has been rarely found in calculous concretions. It was detected mixed with phoſphate of lime, only in two mulberry calculi, which were extremely hard.

2839 Animal matter.

In all calculous concretions there is a quantity of animal matter, which unites or cements together the layers or particles of the hard ſubſtances of which they are compoſed. This animal matter ſeems to poſſeſs the properties of albumen. Sometimes it ſeems to be compoſed of albumen mixed with urea, of coagulated albumen, or gelatine.

2840 Divided into three genera and 12 ſpecies.

4. Fourcroy and Vauquelin have analyzed more than 600 calculi, and by comparing the properties of each, they have arranged them into three genera and 12 ſpecies. The firſt genus comprehends thoſe ſpecies which are compoſed of one ſubſtance. Theſe are the three following:

1. Uric acid,
2. Urate of ammonia,
3. Oxalate of lime.

The ſecond genus includes thoſe ſpecies which are compoſed of two ſubſtances. It conſiſts of the following ſeven ſpecies:

1. Uric acid and the earthy phoſphates, in diſtinct layers.
2. Uric acid and the earthy phoſphates intimately mixed together.
3. Urate of ammonia, and the phoſphates in diſtinct layers.
4. The two preceding intimately mixed.
5. Earthy phoſphates mixed or in thin layers.
6. Oxalate of lime and uric acid in layers.
7. Oxalate of lime and earthy phoſphates in layers.

The third genus conſiſts of two ſpecies, which are compoſed of three or four ſubſtances.

1. Uric acid or urate of ammonia, earthy phoſphates, and oxalate of lime.
2. Uric acid, urate of ammonia, earthy phoſphates, and ſilica.

We ſhall now ſtate the general characters of theſe different ſpecies.

Genus I.

Species 1. *Uric acid.*—Theſe calculi are eaſily known by their colour, which reſembles wood. It is reddiſh, or yellowiſh. They are of a radiated, denſe, fine texture, completely ſoluble in pure alkalies, without emitting any odour. They vary greatly in ſize, and have generally a ſmooth poliſhed ſurface. The ſpecific gravity is from 1.276 to 1.786. It uſually exceeds 1.5. Of 600 calculi which were analyzed by Fourcroy and Vauquelin, 150 conſiſted of pure uric acid. The ſand or gravel which is formed in the kidneys, uſually belongs to this ſpecies.

2. *Urate of ammonia.*—Calculi compoſed of this ſubſtance, are uſually of ſmall ſize, ſoluble in cauſtic fixed alkalies, with the evolution of ammonia, of the colour

of the infuſion of coffee, and are compoſed of fine layers which are eaſily ſeparated. The ſurface is commonly ſmooth, and ſometimes ſhining and cryſtalline. The ſpecific gravity is from 1.225 to 1.720. They are ſoluble in hot water, at leaſt when reduced to powder. The external layer is ſometimes pure uric acid. This ſpecies is rare.

Oxalate of lime.—This ſpecies is eaſily recognized by its rough, mamellated ſurface, from which thoſe calculi have received the name of mulberry ſtones. The colour is brown, they are of a cloſe hard texture, and when raſped or ſawed, emit the odour of ſemen. They are ſoluble with difficulty in acids, and are inſoluble in the pure alkalies. The ſpecific gravity is from 1.428 to 1.976. This ſpecies frequently conſtitutes the nucleus of other calculi.

Genus II.

Species 1. *Uric acid and earthy phoſphates in diſtinct layers.*—This ſpecies is known by its ſurface, which is white like chalk, friable and ſemitranſparent. The external layer is compoſed of the phoſphate of lime, or of ammonia and magneſia. The nucleus conſiſts of uric acid, and when the calculus of this ſpecies is ſawed aſunder, two ſubſtances of which it is compoſed are diſtinctly ſeen. It is indeed only then that the ſpecies can be recogniſed. Calculi of this deſcription are not uncommon, and they are generally of the largeſt ſize of all the urinary calculi. The ſpecific gravity is very variable.

2. *Uric acid and earthy phoſphates intimately mixed.*—This ſpecies contains numerous varieties, from the different proportion of the conſtituent parts. Sometimes the uric acid and the earthy phoſphates are arranged in layers ſo thin, that they are ſcarcely perceptible. Sometimes they are ſo mixed together that they can only be detected by analyſis. But ſometimes the layers are ſufficiently diſtinct. The ſpecific gravity is from 1.213 to 1.739. This ſpecies of calculus is common.

3. *Urate of ammonia and the phoſphates in diſtinct layers.*—In this ſpecies the nucleus conſiſts of urate of ammonia; and the external layers are moſt frequently compoſed of the earthy phoſphates mixed together, or more rarely of phoſphate of ammonia and magneſia. This ſpecies is uſually of ſmall ſize; its ſpecific gravity is from 1.312 to 1.761. It is not very common.

4. *Urate of ammonia and earthy phoſphates mixed.*—The calculi belonging to this ſpecies are very rare. They are of a pale-yellow colour, and of leſs ſpecific gravity than the ſecond ſpecies of this genus, which they reſemble in external characters. When they are treated with potaſh, ammonia is diſengaged. This ſpecies is uſually of ſmall ſize.

5. *Earthy phoſphates mixed, or in thin layers.*—This ſpecies is diſtinguiſhed by its pure white colour. They are of a friable texture, inſoluble in alkalies, and ſoluble in diluted acids. This ſpecies is pretty common, and often of a large ſize. The concretions formed on extraneous matters introduced through the urethra into the bladder, are of this kind. The ſpecific gravity varies from 1.138 to 1.471.

6. *Oxalate of lime and uric acid in diſtinct layers.*—In this ſpecies the nucleus conſiſts of oxalate of lime, and it is covered with a layer of uric acid. From external appearance they are not diſtinguiſhed from thoſe entirely compoſed of uric acid, till they are ſawed aſunder. The ſpecific gravity varies from 1.341 to 1.754.

7. *Oxalate of lime and earthy phoſphates in layers.*—The oxalate of lime conſtitutes the nucleus, and the earthy phoſphates compoſe the external covering in this ſpecies of calculus. It can only be diſtinguiſhed by being ſawn aſunder. The calculi belonging to this ſpecies vary greatly in form and ſize, but they are always white externally. The ſpecific gravity is from 1.168 to 1.752.

Genus III.

Species 1. *Uric acid, urate of ammonia, the earthy phoſphates and oxalate of lime.*—In this ſpecies there are frequently three diſtinct layers. The centre or nucleus is compoſed of oxalate of lime; the next of uric acid or urate of ammonia; and the outermoſt of the earthy phoſphates, which are uſually mixed with uric acid, or urate of ammonia. The calculi of this ſpecies can only be diſtinguiſhed by ſawing them in two. There are many varieties of this ſpecies, from the different proportions and the different arrangement of the conſtituent parts.

2. *Uric acid, urate of ammonia, earthy phoſphates, and ſilica.*—In the calculi belonging to this ſpecies, the ſilica ſeems to hold the place of the oxalate of lime. It is mixed with uric acid and urate of ammonia, and covered with the phoſphate of lime. This is the rareſt ſpecies of all that have been examined.

2841 Cauſes of urinary calculi.

5. The inveſtigation of the cauſe of the formation of calculous concretions has occupied a great deal of the attention of phyſiologiſts and phyſicians, and undoubtedly it is one of the moſt important on which the reſearches of man can be employed; for by obviating the cauſe of this diſorder, its terrible effects might be prevented. Unfortunately, however, little is yet known on this intricate ſubject. In many caſes, indeed, the formation of urinary calculi is obviouſly owing to the introduction of ſome extraneous ſubſtance into the bladder by the urethra. But this mode of formation is comparatively rare, and the calculi thus formed are compoſed of the earthy phoſphates, which are depoſited from the urine. All urine contains uric acid. This forms one of the moſt common ſpecies of calculi. The particles of gravel which are formed in the kidneys, conſiſt of this acid, ſo that it very often forms the nucleus of calculous concretions. But the production of an exceſſive quantity of uric acid, in whatever way this takes place, ſeems to be the moſt powerful cauſe of the production of urinary calculi. It has been obſerved too, that the urine of thoſe perſons in whom theſe concretions are moſt frequent, is loaded with an unuſual proportion of animal matter. This forms the cementing ſubſtance of theſe concretions. In the formation of theſe concretions it would appear that the different ſubſtances of which they are compoſed, are ſecreted at different times, or in different proportions, ſince the different ſucceſſive layers of calculi are compoſed of totally diſtinct ſubſtances. It is perhaps difficult or impoſſible to explain the formation of thoſe calculi in which oxalic acid is a conſtituent part. This acid has ſcarcely ever been detected in the urine, at leaſt of adults, ſo that it muſt be produced by ſome morbid action

tion by which ſome of the animal fluids are converted into this ſubſtance.

2842 Solvents.

6. It has long been an object with phyſicians, to diſcover the means of diſſolving theſe ſubſtances after they have been formed; and the empiric has not been idle in offering his noſtrums which are held out as ſolvents of the ſtone, and which it is no wonder are eagerly received with the hope of relief from one of the moſt dreadful maladies which can afflict mankind. Nothing, however, can be done with this view on rational principles, without previouſly knowing the nature and properties of the ſubſtances which are to be diſſolved; and even when this is known, it muſt appear, from conſidering the function of digeſtion, and the changes which all ſubſtances taken into the ſtomach, undergo, that little can be expected from the exhibition of remedies in this way. After being ſubjected to the different proceſſes of digeſtion, reſpiration, and ſecretion, the properties of theſe ſubſtances are totally changed, ſo that they can only produce ſome general effect on the ſyſtem, and can have no ſpecific action on particular organs. It has therefore been propoſed by the French chemiſts, to employ theſe ſubſtances which poſſeſs the property of diſſolving urinary calculi out of the body, by injecting them through the urethra into the bladder.

It has been found by experiment, that calculi compoſed of uric acid, or urate of ammonia, are ſoluble in ſolutions of pure potaſh and ſoda, even when theſe ſolutions are ſo much diluted with water that they may be taken internally, without producing any inconvenience.

Experiments have alſo ſhewn, that calculi compoſed of the earthy phoſphates are ſoluble in nitric and muriatic acids, ſo much diluted that they may be taken internally without the ſmalleſt injury.

Calculi compoſed of oxalate of lime are leſs eaſily diſſolved. They are, however, ſoluble in diluted ſolutions of carbonate of potaſh or ſoda.

2843 Methods of uſing.

The firſt difficulty, however, which preſents itſelf in the uſe of theſe ſolvents, is to diſcover the nature and compoſition of the concretion to be diſſolved. This can only be done by employing ſome of the ſolutions, and examining them after they have remained for ſome time, or as long as they can be retained in the bladder. If a weak ſolution of potaſh has been injected, it is to be filtered, as ſoon as it is thrown out; and if on the addition of a little diluted muriatic acid, or vinegar, a white precipitate appears, the calculus is to be conſidered as compoſed of uric acid. But if this ſolution has been employed for ſome time, and no precipitate is produced in this way, the ſolution for the phoſphates is then to be employed, and when it is paſſed, after remaining ſome time in the bladder, a precipitate will be formed with the addition of ammonia. This precipitate will be phoſphate of lime.

If no effect is produced by any of theſe ſolutions, and if the ſeverity of the ſymptoms continues, there is ſome probability that the calculus conſiſts of oxalate of lime. This, it has been obſerved, is the moſt difficult of ſolution. It may be diſſolved, however, although ſlowly, in nitric acid greatly diluted with water, or in weak ſolutions of the carbonates of potaſh or ſoda. Theſe ſolutions, therefore, muſt be employed when the others have failed. The effects of theſe ſolutions muſt be judged of by the alleviation of the ſymptoms, or by the actual examination of the ſtone itſelf at different times, by means of the catheter, or ſound. Whatever ſolution is employed, it ought to be of the temperature of the body, and ſo much diluted as not to irritate or injure the internal ſurface of the bladder to which it is applied. Before the injection is made, the urine ſhould be evacuated, and the injection retained, for at leaſt a quarter of an hour, from that to an hour, or as long as it can be done without inconvenience. The injections ſhould be repeated at firſt three or four times a day, and afterwards increaſed to ſix or eight times. As calculous concretions are frequently ſeveral years in forming, it is obvious that they muſt require a long time to diſſolve them, ſo that the uſe of injections, if any relief is to be obtained from them, muſt be long continued.

2844 In other animals.

7. Calculous concretions are not unfrequent in the urinary organs of other animals. They have been found in the horſe, in the dog, the rabbit, the hog, and the rat. They are moſt frequently compoſed of carbonate of lime with ſome animal matter; ſometimes of phoſphate of lime, of phoſphate of ammonia, and of carbonate of lime and phoſphate of lime; but no traces of uric acid have yet been detected in theſe concretions.

2845 Chalk-ſtones.

Gouty concretions.—1. Concretions, which are commonly called *chalk ſtones*, are ſometimes formed in the joints of thoſe who have been long ſubject to the gout. They have been diſcovered by chemical analyſis to be compoſed of uric acid and ſoda.

2846 Properties.

2. Theſe concretions are of a white colour, irregular in their form, and of a fine granulated texture. When they are boiled for a few minutes, in 100 times their weight of water, they are entirely diſſolved. Sulphuric acid added to this ſolution, produces a white precipitate, which aſſumes the form of ſmall needles, which are cryſtals of uric acid. The remaining liquid, by being evaporated, affords ſulphate of ſoda.

2847 Action of alkalies.

3. By treating a quantity of gouty concretion with 100 times its weight of a concentrated ſolution of potaſh with the aid of heat, it is almoſt entirely diſſolved, exhaling at the ſame time the faint odour of animal matter. When the liquid is filtered, and muriatic acid added, it produces a white precipitate, which is uric acid. From this it appears, that gouty concretions poſſeſs ſimilar properties with thoſe formed in the urinary organs, excepting that they contain a greater proportion of animal matter.

2848 Acids, &c.

4. When it is diſſolved in a ſmall quantity of diluted nitric acid, it tinges the ſkin with a roſe colour, and when evaporated, leaves a roſe-coloured deliqueſcent reſiduum. By diſtillation this ſubſtance yields ammonia, pruſſic acid, and an acid ſublimate.

2849 Artificial formation.

5. If a ſmall portion of uric acid be triturated with ſoda and a little warm water, they combine; and after the ſuperfluous alkali has been waſhed out, the remainder has all the chemical properties of gouty matter *.

Subdiviſion IV. Of Subſtances Peculiar to Different Animals.

Having briefly detailed the nature and properties of thoſe ſubſtances which are common to animals, we ſhall now take a general view of ſome ſubſtances which are peculiar to different animals, and we ſhall treat of theſe according to the order in which they are arranged in natural hiſtory.

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* Phil. Trans. 1797. p. 386.

I. Of ſubſtances peculiar to the Claſs Mammalia.

The ſubſtances peculiar to this claſs of animals are the following.

1. Ivory,
2. Horn,
3. Hartſhorn,
4. Wool,
5. Muſk,
6. Civet,
7. Caſtor,
8. Ambergris.
9. Spermaceti,
10. Bezoards.

2850 Ivory.

1. *Ivory*, which is the teeth of the elephant, is a bony ſubſtance, of a fine compact texture, white colour, and ſo hard as to be ſuſceptible of a fine poliſh. It is compoſed, like the bones, of gelatinous matter and phoſphate of lime, and when it is diſtilled, it furniſhes water, a thick oil, and carbonate of ammonia; and when calcined to whiteneſs, it leaves pure phoſphate of lime.

The component parts of ivory are, according to Merat-Guillot, the following.

Phoſphate of lime,	64.0
Carbonate of lime,	0.1
Gelatine,	24.0
Loſs,	11.9
	100.0

2851 Horn.

2. *Horn.*—The ſubſtance called horn, poſſeſſes different properties from that of bone. This matter is produced in the horns of different animals, as thoſe of oxen, ſheep, and goats. It has ſome degree of tranſparency, and when heated it becomes ſo ſoft and flexible, that it may be made to aſſume different ſhapes, and formed into different inſtruments and utenſils. Horn yields a very ſmall proportion of earthy matter. The other conſtituent parts ſeem to be coagulated albumen and gelatine.

The following are the proportions of the conſtituents of hartſhorn.

Phoſphate of lime,	57.5
Carbonate of lime,	1.0
Gelatine,	27.0
Loſs,	14.5
	100.0

2852 Hartſhorn.

3. *Hartſhorn.*—The conſtituent parts of hartſhorn, from the analyſis which has been made, are exactly the ſame as thoſe of bone, but they contain a greater proportion of gelatinous matter.

2853 Wool.

4. *Wool* is a kind of long hair, very fine and ſoft, which is a covering to different animals, eſpecially the ſheep. It has been conſidered as nearly analogous in its nature and properties to hair. It is entirely ſoluble in the cauſtic alkalies, and forms with them a ſoapy matter, which has been employed, it is ſaid, with advantage, as a ſubſtitute for ſoap, in different manufactures.

2854 Muſk.

5. *Muſk* is a ſubſtance which is ſecreted in a bag ſituated near the umbilical region of the muſk deer (*moſchus moſchifer*). It has an unctuous feel, is of a dark-reddiſh brown colour, has a very bitter taſte, and is diſtinguiſhed by a ſtrong aromatic ſmell. It is partially ſoluble in water, to which it communicates the odour. A ſmall portion of it alſo may be diſſolved in alcohol, but it does not retain the odour. Muſk is ſoluble in ſulphuric and nitric acid; but in theſe ſolutions the odour is diſſipated. The ſmell of ammonia is given out by the action of the fixed alkalies on muſk. When it is laid on red hot iron, it takes fire, and is almoſt entirely conſumed, leaving only a ſmall portion of gray aſhes. During its combuſtion it gives out the fetid odour of urine. Muſk ſeems to poſſeſs many of the properties of the volatile oils, but its component parts have not been determined.

2855 Civet.

6. *Civet.*—This ſubſtance is extracted from a ſmall bag near the anus of the *viverra civeta*, or *civet cat*. It is of a yellow colour, and of the conſiſtence of butter. When firſt extracted it is ſaid to be white. It has a very ſtrong ſmell, and ſlightly acrid taſte; it combines readily with oils, and is much employed as a perfume.

2856 Caſtor.

7. *Caſtor.*—This ſubſtance is extracted from two bags ſituated near the anus of the beaver. The beſt caſtor is obtained from the large bag; that which is ſecreted in the ſmall bag is ſaid to be of an inferior quality. When caſtor is firſt taken from the animal, it is nearly fluid, and of a yellow colour. After it is expoſed for ſome time to the atmoſphere, it becomes hard, and of a darker colour, aſſuming a reſinous appearance. It has an acrid, bitter, and nauſeous taſte, and a ſtrong aromatic ſmell, which it loſes by drying. It becomes ſoft in water, and communicates to it a pale yellow colour. This infuſion converts vegetable blues to a green colour. When it has been long macerated in water, the infuſion becomes of a deeper colour, and yields by evaporation extractive matter, which is ſoluble in alcohol and in ether. A reſinous matter is precipitated from the ſolution in alcohol, by means of water, which has ſimilar properties with the reſin of bile. According to the analyſis of Lagrange, the component parts of caſtor are the following:

Carbonate of potaſh,
———— lime,
———— ammonia,
Iron,
Reſin,
Mucilaginous extractive matter,
Volatile oil.

2857 Ambergris.

8. *Ambergris.*—This is a ſubſtance which is ſuppoſed to be formed in the inteſtines of the ſpermaceti whale. It is frequently found floating in the ſea. For its natural hiſtory, ſee AMBERGRIS, and CETOLOGY *Index*.

It is a ſoft light ſubſtance, of an aſh-gray colour, with browniſh-yellow and white ſtreaks. It has an inſipid taſte, but an agreeable odour. The ſpecific gravity is from 0.844 to 0.849. It melts at the temperature of 122°, and with the heat of boiling water is completely diſſipated in white ſmoke, leaving a ſmall trace of charcoal. By diſtillation an acid fluid is firſt obtained, and a light volatile oil; and there remains behind a voluminous maſs of charcoal. By ſublimation benzoic acid is ſeparated.

Ambergris is inſoluble in water. Concentrated ſulphuric acid ſeparates a ſmall portion of charcoal.

It is diſſolved in nitric acid. During the ſolution, nitrous gas, azotic gas, and carbonic acid gas are evolved. A reſinous matter is obtained by evaporating the ſolution. Ambergris is ſoluble in the alkalies, with the aſſiſtance of heat. It is alſo ſoluble in the oils, in alcohol and ether. By the analyſis of Bouillon la Grange, the conſtituent parts of ambergris are the following:

2858 Compoſition.

Adipocire,	52.7
Reſin,	30.8
Benzoic acid,	11.1
Charcoal,	5.4
	100.0*

The ſubſtance called *adipocire* poſſeſſes the mixed or intermediate properties of fat and wax. This name was firſt given by Fourcroy to the matter into which the dead bodies found in the Innocents burying-ground were converted. In appearance and some of its properties it alſo reſembles ſpermaceti.

2859 Spermaceti. 9. *Spermaceti.*—This is a production of the ſame whale which yields the preceding ſubſtance. It is an oily matter which ſurrounds the brain. It is ſeparated from a fluid oil, with which it is mixed, by expreſſion. Spermaceti is alſo found in other cetaceous fiſhes, and in other parts of the body, mixed with the oil.

2860 Properties. It is a fine white ſubſtance of a cryſtallized texture, very brittle, and has little taſte or ſmell. It cryſtallizes in the form of ſhining ſilvery plates. It melts at the temperature of 112°. With a greater heat it may be diſtilled without change; but, by repeated diſtillation, it is decompoſed, and partly converted into a brown acid liquid. It is ſoluble in boiling alcohol, but it ſeparates when the ſolution cools. It is alſo ſoluble in ether, both cold and hot. In the hot ſolution it concretes on cooling into a ſolid maſs.

2861 Action of acids, &c. Spermaceti is ſcarcely at all ſoluble in the acids. It combines readily with the pure alkalies, with ſulphur, and with the fixed oils. By expoſure to the air it becomes rancid. The uſes of ſpermaceti are well known, and particularly in the manufacture of candles.

2862 Bezoards. 10. *Bezoards.*—Theſe are calculous concretions which are found in the inteſtines of different animals belonging to this claſs, particularly the horſe. Some of very large ſize have been found in the elephant and the rhinoceros. Theſe ſubſtances were once celebrated on account of their medical virtues, and they were formerly diſtinguiſhed into oriental and occidental. The firſt were moſt highly valued, and frequently bore a high price, eſpecially the bezoards obtained from a ſpecies of goat which inhabits the Aſiatic mountains. Some that have been examined were compoſed entirely of vegetable matter. In general the nucleus is of vegetable matter, on which phoſphate of ammonia and magneſia or phoſphate of lime have been depoſited. Theſe ſubſtances are diſtinguiſhed by a ſtrong aromatic odour when they are rubbed or reduced to powder. The brown or golden-coloured matter which has been obſerved on the grinding teeth of ruminating animals is found to be of the ſame nature with the bezoards which are formed in the inteſtines.

II. Of Subſtances peculiar to the Claſs of Birds.

The ſubſtances which are peculiar to this claſs of animals are the following.

1. Eggs.
2. Feathers.
3. Excrement.
4. Membrane of the ſtomach.

2863 Eggs. 1. *Eggs*—In a chemical view, three parts of an egg merit attention. Theſe are the ſhell or external covering, the white, and the yolk. The white of egg, which conſiſts of albumen, has been already deſcribed, ſo that it now only remains to give ſome account of the ſhell and the yolk.

2864 Shells. The ſhells of the eggs of birds which have been analyzed are compoſed of ſimilar conſtituents with bone, but in very different proportions. The following is the reſult of the analyſis of Vauquelin.

Carbonate of lime,	89.6
Phoſphate of lime,	5.7
Animal matter,	4.7
	100.0*

2865 Yolk. The yolk of egg is of a ſoft conſiſtence, a yellow colour, and of a mild oily taſte. It becomes ſolid by boiling, and crumbles eaſily into ſmall particles. By heating gently after it has been boiled, and by expreſſion, an oily liquid of a yellow colour, and inſipid taſte, is obtained. It is diſtinguiſhed by the properties of fixed oil. What remains after ſeparating the oil is albumen, ſtill coloured with a ſmall portion of oil. By boiling this reſiduum in water, a portion of gelatine is obtained, ſo that the yolk of egg is compoſed of oil, albumen, gelatine, and water. 2866 Compoſition.

2867 Feathers. 2. *Feathers.*—are conſidered as poſſeſſing ſimilar properties with hair. According to ſome, the ſolid part or quill, may be reduced to the gelatinous ſtate by boiling; but according to others, no gelatine whatever can be detected. The quill part is therefore ſuppoſed to conſiſt chiefly of coagulated albumen. It becomes ſoft by the action of acids and alkalies.

2868 Excrement. 3. *Excrement.*—This matter in birds is very different from that of the animals included in the claſs mammalia. It is generally of a white colour, leſs liquid, and leſs fetid. It is commonly accompanied with a glary matter of different degrees of tranſparency, analogous to the white of egg. This ſeems to be owing to a quantity of albumen which is ſecreted in the oviduct. The white part of this matter is compoſed of carbonate and phoſphate of lime and albumen. The colouring matter ſeems to be part of the food.

2867 Membrane of the ſtomach. 4. *Membrane of the ſtomach.*—The internal ſurface of the gizzard, or muſcular part of the ſtomach of birds, is covered with a wrinkled membrane, which is ſuſceptible of conſiderable extenſion, and through the pores of which gaſtric juice is copiouſly ſecreted. This membrane is eaſily ſeparated from the muſcular part. When it is boiled in water, it is converted into jelly, and communicates to the water the property of reddening vegetable blues, and coagulating milk. When it is dried and reduced to powder, it produces the ſame effect.

III. Of

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* *Ann. de Chim.* xlvii. 84.

* *Ann. de Chim.* xxix. 6.

III. Of Matters peculiar to Animals in the Amphibious Claſs.

2868 Poiſon of the viper.

1. *Poiſon of the Viper.*—Some of the animals belonging to the ſnake tribe, ſecrete a peculiar fluid in the mouth, which is of a poiſonous quality. The poiſon of the viper is a yellow, viſcid liquid, ſomewhat reſembling oil. It is ſecreted in two ſmall bags, and from them conveyed to the fangs of the animal, which are hollow and perforated, and when it bites, the liquid is ſqueezed out of the bag, and flows through the teeth into the wound. It has no ſmell. It becomes thick by expoſure to the air, and is converted into a tranſparent jelly; but it retains its poiſonous property long after it is ſeparated from the animal. It is ſoluble in water by agitation, but if thrown into the water when extracted from the veſicle, it falls inſtantly to the bottom like a heavy oil. It is ſoluble in warm water after it is dried, but not ſoluble in alcohol, or coagulated by boiling water. Acids and alkalies produce no perceptible change upon this matter. It is precipitated from its ſolution in water by alcohol. It reſembles gum in ſo many of its properties, that it has been called an *animal gum.*

2869 Toad.

2. *Liquid ſecreted from the tubercles on the head of the Toad.*—It has been long ſuppoſed that the liquid ſecreted on the head of the toad is of a poiſonous quality; but although it is ſaid by ſome naturaliſts, that this fluid, brought in contact with the ſkin, produces inflammation, yet there ſeems to be no poſitive proof of this effect.

2870 Tortoiſe ſhell.

3. *Tortoiſe-ſhell.*—This ſubſtance, which forms a ſtrong covering and defence to the body of the turtle, poſſeſſes many of the properties of horn; for it may be ſoftened with heat, or in boiling water, and ſhaped into any form which may be wanted. It is compoſed of a number of hard plates or membranes, of different degrees of thickneſs, cloſely applied to each other. It becomes ſoft by maceration in nitric acid, and by burning it yields a very ſmall proportion of phoſphate of lime and ſoda, with ſome ſlight traces of iron.

IV. Of Subſtances peculiar to Fiſhes.

2871 Scales.

1. *Scales*—generally poſſeſs a ſilvery whiteneſs, and are compoſed of different laminæ. In many of their properties they reſemble horn. By long boiling in water they become ſoft, and when they are kept for ſome hours in nitric acid, they are converted into a tranſparent membraneous ſubſtance. By ſaturating the acid with ammonia, a precipitate is formed, which is phoſphate of lime. The conſtituent parts of ſcales, therefore, are membrane and phoſphate of lime.

2872 Bones.

2. *Bones of fiſhes.*—Theſe are compoſed of the ſame conſtituents as thoſe of other animals, but have a greater proportion of animal matter. In ſome they are ſoft, flexible, and ſemitranſparent, and hence they are called *cartilaginous.* In others they are hard and ſolid, having the uſual appearance of bone.

3. *Fiſh oil.*—A great quantity of oil is extracted from the ſoft parts of different kinds of fiſh, and eſpecially from the blubber of the whale. It is uſually denominated *train oil.* It is obtained, either by expreſſion, or by boiling. It is ſuppoſed that the oil obtained from the blubber of the whale, and from other fiſhes, poſſeſſes different properties, which are aſcribed to the difference in the function of reſpiration of cetaceous and other fiſhes; but how far this difference really exiſts, does not ſeem to have been accurately aſcertained. Fiſh oil is diſtinguiſhed by a diſagreeable ſmell, and it has long been an object to deprive it of this odour, as it is much employed in domeſtic economy and in many arts. By agitating the oil with a ſmall portion of ſulphuric acid, and adding water, the oil when left at reſt, riſes to the ſurface conſiderably purified. A portion of coagulated matter has ſeparated, and the water is milky.

V. Of Subſtances peculiar to Inſects.

1. *Wax.*—The nature and properties of this ſubſtance have already been deſcribed as a vegetable production.

2873 Propolis.

2. *Propolis.*—This is a ſubſtance collected by bees, and with which they cover the bottom of the hive, or any foreign matters which happen to be introduced into it, which they cannot remove. It is the ſubſtance which they collect on their legs and thighs. It is perhaps more properly to be conſidered as a vegetable production. It poſſeſſes more tenacity than wax, but has much of its ductility. It is inſipid to the taſte, but is diſtinguiſhed by an aromatic odour. It is partially ſoluble in alcohol, to which it communicates a red colour. Another portion is diſſolved in boiling alcohol, and part precipitates as the ſolution cools, which has the properties of wax. A reſinous maſs is obtained by concentrating the ſolution in alcohol and boiling in water. It is ſemitranſparent and brittle. An acid was detected in the water in which it was boiled. The reſinous ſubſtance is ſoluble in fixed and volatile oils. The following are the conſtituent parts of propolis.

Pure reſin	57
Pure wax	14
Extraneous matter	14
Loſs and acid	15
	100*.

2874 Honey.

3. *Honey.*—This alſo has been conſidered as a vegetable production, as it is collected from plants by bees. It is of a white or yellowiſh colour, of a granular ſoft conſiſtence, and has an aromatic ſmell; but theſe properties vary according to the plants from which it is collected, or the climate in which they grow. By diſtillation honey yields nearly the ſame products as ſugar. It is converted into oxalic acid by means of nitric acid. It is very ſoluble in water, and is even ſomewhat deliqueſcent. It readily paſſes to the vinous fermentation, and affords a fermented liquor which has been called *hydromel.* It is partially ſoluble in alcohol, and by this means ſugar may be extracted from it. The component parts of honey are ſugar, mucilage, and an acid. If pure honey be melted, and carbonate of lime be added till the efferveſcence ceaſes, the ſugar is ſeparated, and is depoſited in cryſtals.

2875 Cantharides.

4. *Cantharides* are a ſpecies of fly, (the *meloe veſicatorius*, Lin.) which are much employed, from a peculiar property they poſſeſs, to raiſe bliſters on the ſkin. For this purpoſe the whole of the inſect is re-

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* *Nichol. Jour.* v. p. 49.

duced to powder. Cantharides have been ſubjected to analyſis; and by ſucceſſive treatment with water, alcohol, and ether, four different ſubſtances have been extracted. 1. Three-eighths of their weight conſiſt of extractive matter, of a reddiſh-yellow colour, very bitter, and which yields by diſtillation an acid liquor. 2. A little more than one-tenth of the weight conſiſts of a concrete oil, ſomething of the nature of wax, which is of a green colour and very acrid taſte. To this is owing the peculiar odour of cantharides. This ſubſtance yields by diſtillation, a very pungent acid ſubſtance and a thick oil. 3. About one-fiftieth of a yellow concrete oil, which ſeems to communicate the colour to the inſect, is alſo obtained. 4. About one-half the weight of a ſolid matter remains, the nature of which has not been aſcertained. The bliſtering effect of cantharides ſeems to depend on the green waxy matter, part of which is extracted by means of warm water, and it is entirely ſoluble in ether.

2876 Millepedes. *Millepedes.*—Theſe inſects, which are different ſpecies of oniſcus, were formerly employed in medicine. By diſtillation with the heat of a water bath, they yield a watery liquid, which converts the ſyrup of violets to a green colour, and by this proceſs they are deprived of five-eighths of their weight. By treating them afterwards with water and alcohol they furniſh one-fourth of their weight of an extractive and waxy matter; the latter is ſoluble in ether. The muriates of potaſh and lime have been detected in the expreſſed juice of theſe inſects.

2877 Ants. *Ants.*—Theſe inſects contain an acid liquid which they emit from the mouth when they are irritated, or when they are bruiſed on paper. This liquid converts vegetable blues to red; and it has been obſerved that ſtreaks of the ſame colour are communicated to blue flowers, over which the inſects creep. The acid obtained from ants, and particularly from the *formica rufa*, or red ant, was formerly conſidered as poſſeſſing peculiar properties, and thence denominated *formic acid*; but it has been lately aſcertained to conſiſt of a mixture of acetic and malic acids.

2878 Lac. *Lac.*—This is a ſubſtance which is formed on the branches of ſeveral plants, as the *ficus indica*, the *ficus religioſa*, and eſpecially the *croton lacciferum*. It is produced by the puncture of an inſect, but is conſidered as belonging to vegetable ſubſtances, among which the general properties have been already deſcribed, as well as the properties of an acid obtained from it, among the acids.

2879 Silk. *Silk.*—This is the production of ſeveral inſects, either for the purpoſe of covering up their eggs, or forming a net to catch their prey, as is the caſe with many of the ſpider tribe, or to cover up the inſect during one of the ſtages of its metamorphoſis. The ſilk of commerce is uſually obtained from the *phalæna bombyx*, or ſilk-worm. This ſubſtance is prepared in the body of the larva of the inſect, from which it is protruded through ſeveral ſmall orifices in very fine threads; and with this it forms a covering for itſelf while it remains in the ſtate of chryſalis or pupa.

Silk is a very elaſtic ſubſtance, and is of a white or reddiſh yellow colour, when it is produced by the inſect. The elaſticity of ſilk has been aſcribed to a varniſh with which it is covered, of a gummy or gelatinous nature, which is precipitated by tan and muriate of tin. The yellow colour of ſilk is aſcribed to a reſinous matter which is ſoluble in alcohol. By diſtillation ſilk yields a large proportion of ammonia. It is ſoluble in ſulphuric, nitric, and muriatic acids. By nitric acid it is partly converted into oxalic acid, and a fatty matter which ſwims on the ſurface.

2880 Cochineal. *Cochineal.*—This is an inſect which breeds on the leaves of the *cactus coccinelliferus* Lin. ſometimes called opuntia or nopal. The plant is cultivated in Mexico, for the purpoſe of rearing the inſects, which are collected, dried, and employed as a beautiful dye ſtuff. By burning, the ſame reſults are obtained as from other animal matters; but with boiling water it gives a crimſon violet colour, which becomes red and yellow by the action of acids, while a precipitate is formed of the ſame colour. The metallic ſolutions added to this decoction, alſo produce a coloured precipitate. The muriate of tin throws down a beautiful red precipitate. The evaporated reſiduum of the decoction of cochineal treated with alcohol, gives a fine red colour, and this, by evaporating the alcohol, aſſumes the form of a reſin. Oxymuriatic acid converts the ſolution of this ſubſtance into a yellow colour, from which the proportion of colouring matter may be in ſome meaſure eſtimated, by the quantity of acid requiſite to deſtroy its colour. Cochineal is well known by its producing a beautiful ſcarlet colour. It may be kept for any length of time, at leaſt in a dry place, without being deprived of its colouring matter. It has retained this property for 130 years. Cochineal is employed in the preparation of the beautiful lake called *carmine*.

2881 Kermes. *Kermes.*—This alſo is an inſect which is employed in dyeing, from whence it has been called *coccus infectorius*. It is the *coccus ilicis* Lin. and is produced on a ſmall kind of oak, the *quercus coccifera*. The inſect attaches itſelf to the bark of the tree by a ſoft ſubſtance, which poſſeſſes many of the properties of caoutchouc.

When the living inſect is bruiſed, it gives out a red colour. It has a ſlightly bitter, rough, pungent taſte, but its ſmell is not unpleaſant. The dried inſect, or the kermes, imparts this odour and taſte to water and to alcohol, and communicates alſo to theſe liquids a deep red colour. By evaporation, an extract of the ſame colour is obtained. It is employed in dyeing, and has been alſo uſed in medicine.

2882 Crabs eyes. *Crabs eyes.*—The ſubſtance which has received this name, merely from its form, is a concrete body, convex on one ſide, and concave on the other. Two of theſe bodies are uſually found in the ſtomach of the crab, about the time that it changes its ſhell. After the ſhell is fully formed, they are no longer found, ſo that they are ſuppoſed to furniſh the materials of the new ſhell. They are entirely compoſed of carbonate of lime, a ſmall proportion of phoſphate of lime, and gelatine.

The cruſtaceous coverings of the crab, lobſter, and ſimilar animals, are compoſed of carbonate of lime, phoſphate of lime, and animal matter, or cartilage.

VI. Of Subſtances peculiar to Teſtaceous Animals.

The only ſubſtances to be mentioned peculiar to this

Component Parts of Animal Subſtances.

this claſs of animals are, ſhells, mother of pearl, and pearl.

2883 Shells. 1. *Shells.*—Such as have been particularly examined by Mr Hatchett, are divided into two claſſes. In the one he includes thoſe which have the appearance of porcelain, and have an enamelled ſurface, which he calls *porcellaneous ſhells.* Such are the various ſpecies of *voluta* and *cypræa.* Theſe ſhells were found by analyſis to be compoſed of carbonate of lime, with a ſmall portion of animal gluten.

2884 Mother of pearl. 2. *Mother of pearl.*—The ſecond claſs comprehends thoſe which are generally covered with a ſtrong epidermis, under which is the ſhell, compoſed chiefly of the ſubſtance called *nacre*, or *mother of pearl.* Such are the *oyſter*, the *river muſſel*, the *haliotis iris*, and the *turbo olearius*. In theſe the proportion of carbonate of lime is ſmaller, and that of the animal matter, greater.

2885 Pearl. 3. *Pearl.*—This is a concretion formed in ſeveral ſpecies of ſhells, as in ſome ſpecies of the oyſter and the muſſel. It is conſidered by ſome as a morbid concretion, owing to an exceſs of the ſhelly matter, or to a wound of the ſhell containing the animal. Pearls are of a ſilvery or bluiſh-white colour, irideſcent and brilliant. The refraction of the light is aſcribed to the lamellated ſtructure, for they conſiſt of concentric layers of carbonate of lime and membrane alternately arranged. The conſtituent parts of pearl are the ſame as mother of pearl.

VII. Subſtances peculiar to Zoophytes.

2886 Zoophytes. The zoophytes, many of which have been examined by Mr Hatchett, are compoſed of carbonate of lime, phoſphate of lime, and animal matter of different degrees of conſiſtency. In ſome the conſtituents are only carbonate of lime and a gelatinous matter. Such are ſome ſpecies of the madrepore, as the *madrepora muricata*, *virginea*, and *labyrinthica ;* ſome ſpecies of millepore, as the *millepora cerulea* and *alcicornis*, and the *tubipora muſica.* Others again are compoſed of carbonate of lime and a membranaceous ſubſtance, Such are the *madrepora faſcicularis*, the *millepora celluloſa* and *faſcialis*, and the *iris hippuris.* White coral and articulated coralline are compoſed of ſimilar ſubſtances. Another diviſion of zoophytes are compoſed of carbonate of lime, a ſmall portion of phoſphate of lime, and membrane. Such are the *madrepora polymorpha*, the *gorgonia nobilis* or *red coral*, and the *gorgonia ſetoſa ;* but ſome of the zoophytes are alſo found to conſiſt chiefly of animal matter, with ſcarcely any portion of earthly ſubſtance. To this diviſion belong ſome ſpecies of gorgonia, and many ſpecies of ſponge.

Chap. XX. *Of Arts and Manufactures.*

In this chapter it was intended to give a general view of the application of the principles of chemiſtry to different arts and manufactures, ſuch as the manufacture of ſoap, of glaſs and porcelain ; the arts of dyeing, bleaching and tanning. In this view it was propoſed to explain the principles of theſe arts and manufactures, ſo far as they depend on chemiſtry, leaving the detail to the different treatiſes on thoſe ſubjects in the courſe of the work. But the unavoidable length to which this article has extended, obliges us to refer our readers for the whole to the different treatiſes.

APPENDIX.

After the chapter on earths was printed off, we received the account of a new earth diſcovered by Klaproth.

Of *Ochroit.* This earth was diſcovered in a mineral to which Klaproth has given the name of ochroites, of which the external characters are the following :

1. The colour of this mineral is between carmoiſin red, clove-brown, and reddiſh-brown. It is compact, breaks ſplintering in irregular but not very ſharp or angular pieces. It is perfectly opaque, the powder is reddiſh-grey ; it is not very hard, but brittle. The ſpecific gravity is 4.60. This mineral is found in the mine of Baſnæes, near Riddarhytta in Weſtmannland.

2887 Analyſis of the ochroites. A. " *a.* A piece of the mineral, after having been ignited to redneſs, loſt two per cent. Its reddiſh colour had been changed to brown. Its figure had ſuffered no alteration.

" *b.* One hundred grains of the finely levigated mineral ignited for half an hour, loſt five grains. Its colour was changed to a dark brown.

B. *a.* One hundred grains of ochroit, after being mixt with 200 grains of carbonate of potaſh, were ſtrongly ignited, the maſs which could not be rendered fluid, was reddiſh gray, and brittle. On being diffuſed through water, as uſual, the obtained ſolution was colourleſs. It remained perfectly tranſparent ; a proof that it did not contain tungſten oxide ; nitrate of ſilver, mercury, lead, barytes, &c. proved the abſence of acids.

b. The inſoluble reſidue of the laſt proceſs was boiled in nitro muriatic acid, the ſiliceous earth being ſeparated, the ſolution was decompoſed by potaſh, and the whole boiled for ſome time. The alkaline fluid, after being neutralized with muriatic acid, and then mingled with carbonate of potaſh, ſuffered no change.

C. *a.* Two hundred grains of the finely pulverized mineral, were firſt boiled in two ounces of muriatic acid, to which half an once of nitric acid was gradually added, and the digeſtion continued for ſome time. The whole became thus diſſolved except the ſilex contained in the mineral. Its quantity amounted to 68 grains.

b. To the ſolution obtained in the laſt proceſs, carbonate of ammonia was added ſo long, till no permanent precipitate was produced. On letting fall into it ſuccinate of ammonia, a curdly precipitate fell, which vaniſhed again on agitation, leaving merely a pale red precipitate of ſuccinate of iron. This being collected, waſhed, dried, and ſtrongly ignited, yielded nine grains of oxide of iron.

c. The fluid thus freed from iron, and now colourleſs, was decompoſed by carbonate of ammonia. The precipitate obtained was white, and weighed 168 grains; on being deprived of water and carbonic acid by heat, its white colour changed to cinnamon-brown. It weighed 109 grains.

d. All the water employed for waſhing the different precipitates were mingled, evaporated to dryneſs, and the ammoniacal ſalt volatilized; a minute quantity of a muriate was obtained, the baſis of which could not be determined.

2888 Peculiar earth.

From what follows it will become evident, that the cinnamon-brown precipitate (*c*.) which forms the principal part of the foſſil, is a peculiar earth, diſtinct from all the others hitherto known. The characteriſtic property which it poſſeſſes of acquiring a light-brown colour after being heated, has induced me to call it ochroit earth (A), which may alſo ſerve for the mineral itſelf.

According to this analyſis, 100 parts of the ochroit of Riddarhytta contain,

Ochroit earth,	54,50
Silex,	34
Oxide of iron,	4
Water, &c. (A. *b*.)	5
Loſs,	2
	100

Characteriſtic Properties of Ochroit Earth.

2889 Ochroit earth combines with carbonic acid.

1. Ochroit earth is capable of combining with carbonic acid during its precipitation from acids by carbonated alkalies, and ſtrongly conſolidating a portion of water.

One hundred grains of the earth precipitated by carbonate of ammonia, and ſtrongly dried, loſt on being neutralized by nitric acid, 23 grains: 100 grains of the ſame earth loſt, after being ſtrongly ignited, 35 grains: 100 parts of carbonate ochroit, therefore, conſiſts of

Ochroit earth	65
Carbonic acid	23
Water -	12
	100

2. Ochroit earth, after being freed from carbonic acid and water, by heat, always appears in the form of a cinnamon-brown powder. The intenſity of the colour is in proportion to the heat applied. This colour is not owing to the preſence of iron, or manganeſe, &c. but it is a characteriſtic property of the earth.

3. Ochroit earth included in a charcoal crucible, and expoſed to the heat of the porcelain furnace, ſuffered no change whatever.

4. Urged by the blow-pipe, it becomes phoſphoreſcent; fuſed with phoſphate of ſoda and ammonia, it becomes tinged by it, without effecting a ſolution of the earth. The ſalt acquires merely a marbled lemon-yellow colour. Borax has likewiſe no chemical effect upon it. This ſalt only effects a mechanical diviſion. The earth always appears diffuſed through the borax in minute *flocculi*.

5. Ochroit earth mixed in different proportions with proper fluxes, and applied for painting of porcelain, proved unſucceſsful. The painted articles were light-brown, but the colour was not uniform; a proof that no combination had been effected.

6. Ochroit earth combined with carbonic acid is eaſily ſoluble with effervescence in acids. The taſte of the ſolution is very rough and aſtringent. The concentrated ſolution is of an amethyſt-red colour; diluted with water, it becomes colourleſs. Ignited ochroit earth, on the contrary, is difficultly ſoluble in acids in the cold; if nitric acid be employed, the ſolution is yellowiſh red.

7. The combination of ochroit earth with ſulphuric acid, is cryſtallizable. The figure of the cryſtals formed in the maſs of the fluid is the octahedron. They are heavy, of a pale-amethyſt colour, and difficultly ſoluble in water; but the ſulphate of ochroit, with exceſs of acid, is more ſoluble; the figure of the cryſtals formed on the ſides of the veſſel, is needle-ſhaped, radiating from a centre. They are more ſoluble than the former.

8. If a ſolution of ſulphate of ſoda be mingled with a ſolution of muriate or nitrate of ochroit, a mutual decompoſition takes place. A white inſoluble precipitate is formed, conſiſting of ſulphuric acid united to the ochroit earth. This combination may be decompoſed by boiling it with double its weight of carbonate of ſoda. By this means ochroit earth may be obtained very pure.

9. Ochroit earth is likewiſe ſoluble in ſulphurous acid, the ſolution cryſtallizes in needles of a pale amethyſt colour.

10. Muriatic acid diſſolves ochroit earth, and yields cryſtals, the figure of which is the priſm. It is ſoluble in alcohol without imparting to its flame any particular colour.

11. Acetite of ochroit could not be cryſtallized, but yielded an adheſive maſs.

12. Nitrate and muriate of ochroit are decompoſable by carbonated earths and alkalies, the precipitate is milk-white. Alkalies and earths freed from carbonic acid, occaſion a yellowiſh-gray precipitate.

13. Pruſſiate of potaſh precipitates ochroit from all its neutral ſolutions, milk-white. The precipitate is ſoluble in muriatic and nitric acid (B).

14. Tincture of galls occaſions no change in the ſolutions of this earth.

15. Hydroguretted hydroſulphuret of ammonia precipitates the ſolution of ochroit earth, yellowiſh white.

16. Water impregnated with ſulphurated hydrogen occaſions no change in the ſolutions of ochroit earth.

17. Succinates precipitate ochroit earth white.

18. Phoſphate

(A) From the Greek word ωχρος, (*flaveſcens*), browniſh-yellow.

(B) If the earth contained the muriates and quality of iron, it becomes by this means manifeſted.

18. Phoſphate of ſoda occaſions in the ſolutions of this earth a white precipitate, which again vaniſhes by the addition of nitric or muriatic acid.

19. Tartrites of potaſh alſo precipitate this earth white.

20. Oxalates effect a like decompoſition, the oxalite of ochroit, however, is not ſoluble in nitric or muriatic acids.

21. Alkalies and alkaline carbonates do not act on ochroit earth.

22. Ammonia feebly acts on it, under certain circumſtances, as may be evinced from the following experiment :

A ſolution of nitrate of ochroit, prepared by diſſolving 100 grains of carbonate of ochroit (not abſolutely free from iron,) in nitric acid, was decompoſed by carbonate of ammonia, and digeſted in the fluid, containing a conſiderable quantity of carbonate of ammonia in exceſs, for ſome days. The fluid which had acquired a yellow colour, was ſeparated and neutralized by ſulphuric acid, and then ſet in a warm place. A gray precipitate was thus obtained, which, on being dried, weighed $1\frac{1}{4}$ grains. This precipitate, after being diſſolved in nitric acid, yielded a blue precipitate by pruſſiate of potaſh ; this being ſeparated, a white flocculent precipitate fell down by dropping into the remaining fluid carbonate of potaſh. This method is, therefore, applicable for ſeparating a minute quantity of iron, that may be contained in the fluid.

2890 General remarks and characters of the ochroit earth.

" From what has been ſtated, it becomes obvious, that the ochroit earth bears the neareſt relation to yttria ; for, like this, it forms a connecting link between the earths and the metallic oxides. Like yttria, it has the property of forming a reddiſh coloured ſalt with ſulphuric acid, and is precipitable by pruſſiate of potaſh ; but differs from yttria, that it does not form ſweet ſalts, that it is not (at leaſt very ſparingly) ſoluble in carbonate of ammonia ; and that, when ignited, it acquired a cinnamon-brown colour. It farther differs from yttria by not being ſoluble in borax or phoſphate of ſoda when urged upon charcoal before the blow-pipe, which ſalts eaſily effect a ſolution of yttria, and melt with it alſo into a pellucid pearl"*.

---

* *Nichol. Jour.* viii. p. 212.

ERRATUM in CHEMISTRY.

P. 508. l. 10. col. 2d. It is ſaid that Mr Keir found that ſulphuric acid froze at 45° Fahrenheit. This is only inferred from the thermometer being ſtationary at 45° during the melting of the frozen acid. A greater degree of cold was always found neceſſary for its congelation. *Phil. Tranſ.* 1787. p. 279.

EXPLANATION of the PLATES.

Plate CXLII.

Fig. 1. Repreſents Harriſon's pendulum conſtructed on the principle of the unequal expanſion of metals.

Fig. 2. The calorimeter of Lavoiſier and Laplace, ſee page 476.

Fig. 3. Iron bottle and bent gun-barrel for procuring oxygen gas from mangeneſe. The black oxide is reduced to powder, and introduced into the bottle A. The bent tube is put on the mouth of the bottle at C, and luted with the materials deſcribed at the foot of page 490. The bottle is then expoſed to a red heat, and the gas which comes over is received in jars on the pneumatic apparatus.

Fig. III. and 4. repreſent the apparatus for the decompoſition of water. See page 496.

Fig. 5. Pneumatic trough for collecting gaſeous bodies. Suppoſe a quantity of ſulphurated hydrogen gas is to be collected, which is deſcribed in page 505. The iron filings and ſulphur which were melted together in a crucible, and which then form a black brittle maſs, are to be introduced into the glaſs veſſels. Fig. 6. B is a bent tube ground to fit the mouth D, and is air-tight. To the other mouth C is fitted the ground ſtopper A. One end of the bent tube is fitted into the mouth D, and the other placed under the glaſs jar F on the ſhelf of the pneumatic trough E, which is filled with water about an inch above the ſurface of the ſhelf. The jar is alſo previouſly filled with water, cautiouſly inverted, and ſet on the ſhelf. The apparatus being thus adjuſted, muriatic acid is poured into the opening C, and the ground ſtopper is immediately replaced. A violent efferveſcence takes place, a great quantity of gas is diſengaged, and as there is no other way for it to eſcape it paſſes into the glaſs jar. When this is filled, it is removed to another part of the ſhelf ; another jar which was previouſly filled with water is put into its place, and ſo on till the whole gas is collected.

Fig. 7. Papin's digeſter. A is the body of the veſſel, which has been generally made of copper or iron, very thick and ſtrong. BB are two ſtrong bars fixed to the ſides of the veſſel. To the upper end of theſe bars is fixed the croſs bar C, through which paſſes a ſtrong ſcrew D, which preſſes on the lid of the veſſel at E, ſo that it is enabled to reſiſt the elaſtic force of the vapour ; and the water can thus be raiſed to a higher temperature than the ordinary boiling point.

Fig. 8. This repreſents an apparatus for diſtillation. A is the furnace, B is the body of the ſtill, which is generally made of copper ; C is the top or head, made of the ſame metal. The vapour as it riſes from the liquid by the application of heat, paſſes along the tube D, which communicates with a ſpiral tube in the refrigeratory E, which being filled with cold water, the vapour is condenſed, and paſſes out at the other extremity of the tube F, and is received in the veſſel G.

Plate CXLIII.

Fig. 9. Glaſs Retort.
Fig. 10. Tubulated retort.
Fig. 11. Glaſs Alembic.
Fig. 12. Solution glaſs.
Fig. 13. Crucible.

Fig. 14. Apparatus for obtaining muriatic acid from muriate of ſoda by ſulphuric acid. The muriate of ſoda is introduced into the retort A, and by means of the bent tube B the ſulphuric acid is added. The matraſs C is adapted to the retort, to receive the portion of impure ſulphuric acid and muriatic acid which paſſes over towards the end of the operation. D, E, and F, are bottles containing water; the quantity of which ſhould be equal in weight to that of the ſalt employed. Theſe bottles are furniſhed with tubes of ſafety GG; or the tube of ſafety may be applied as H in the bottle E.

Fig. 15. Apparatus for impregnating fluids with gaſes. A is a tubulated retort which is joined to B, a tubulated receiver, from which a bent tube C paſſes to the ſecond receiver D. This laſt communicates with the bottle F by means of the bent tube E. The end of the tube C which enters the receiver D, is furniſhed with a valve which prevents the return of any gas from the receiver D to the receiver B, in caſe a vacuum ſhould take place in the courſe of the operation in the receiver B, or in the retort A. The gas which is not abſorbed by the water in the receiver D, paſſes through the tube E to the bottle F.

Fig. 16. A gazometer, which is a convenient apparatus for holding gaſes. It is uſually made of tin plate A is an inverted veſſel, which exactly fits another, which is fixed within the cylinder B. When it is preſſed down to the bottom of the cylinder, water is poured in, by which means the ſmall quantity of air which remains in the intermediate ſpaces, is forced out, and the gas to be preſerved may be introduced at the lower ſtop-cock C. The veſſel A is nearly balanced by the weights DD, which are connected with it by means of the cords *a a a a*, which move on the pullies *b b b b*. As the gas enters the apparatus, it forces up the veſſel A, and in this way it may be completely filled. It is forced out by turning the ſtop-cock E, and preſſing down the veſſel A, and may be conveyed into a pneumatic apparatus, and received in jars by means of the flexible tube F.

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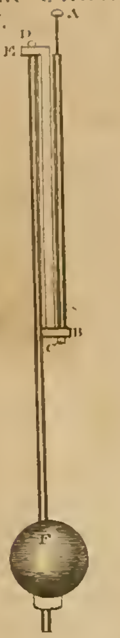
Fig. 1.



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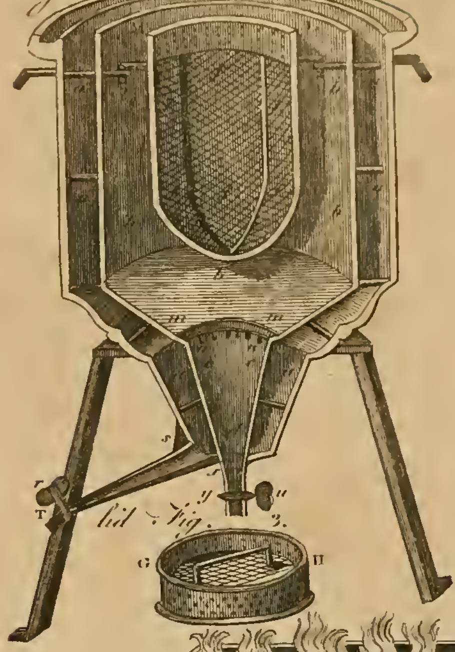

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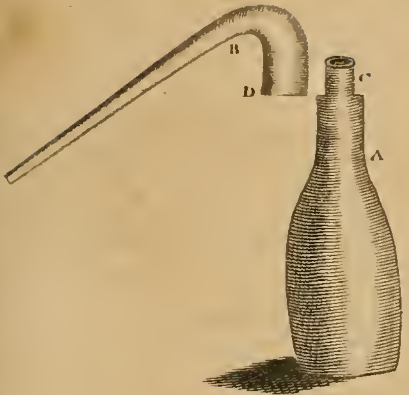

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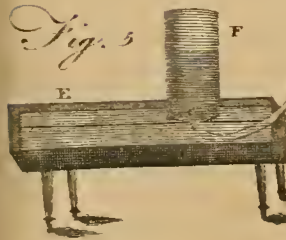

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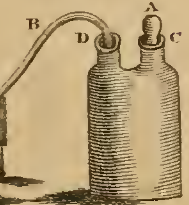

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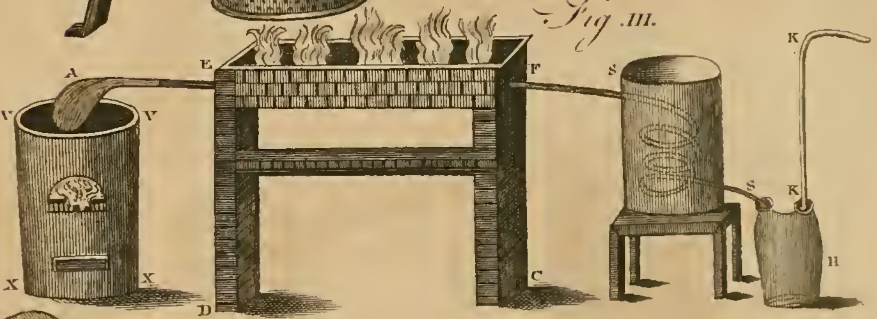

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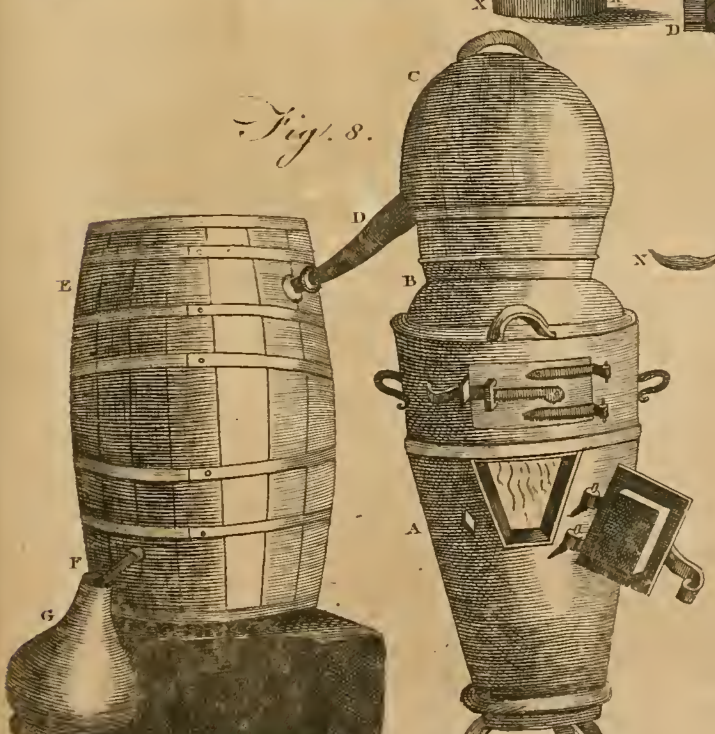

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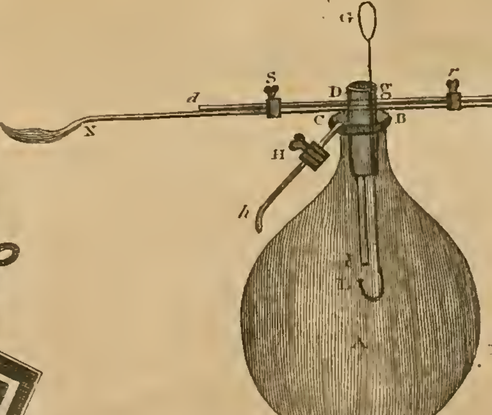

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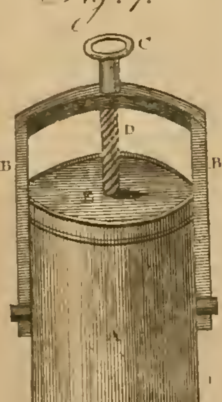

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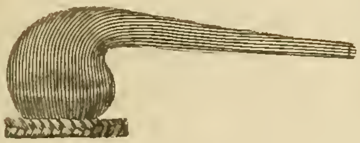

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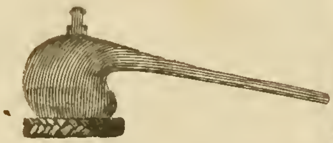

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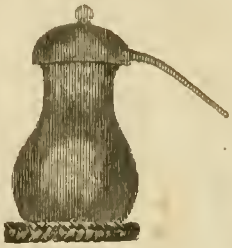

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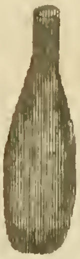

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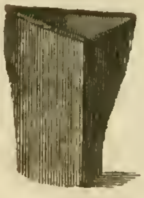

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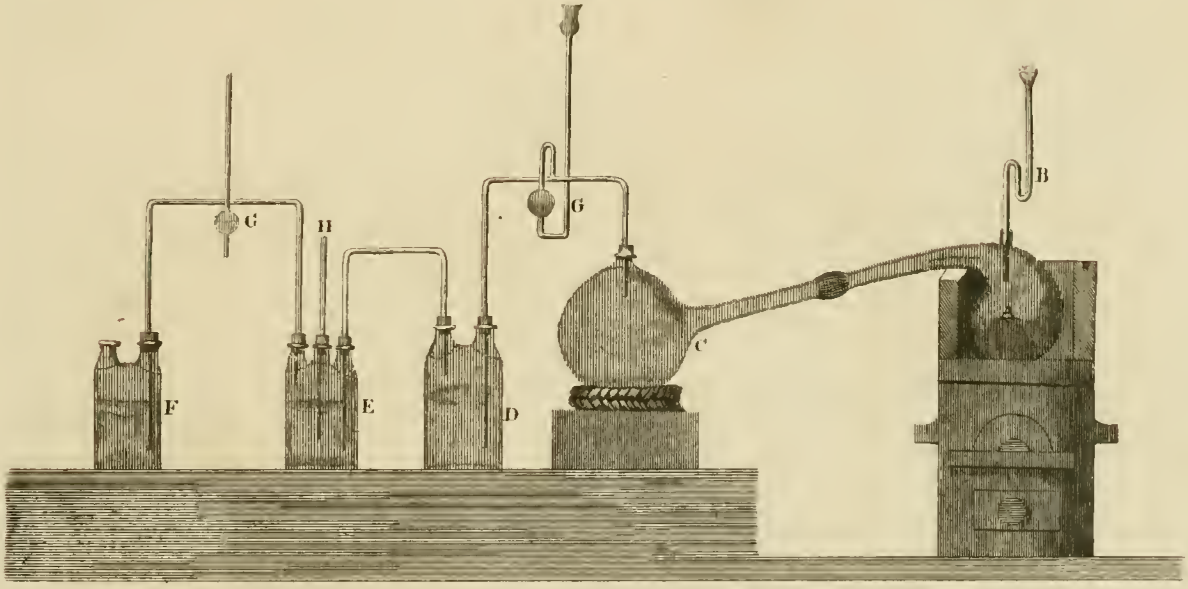

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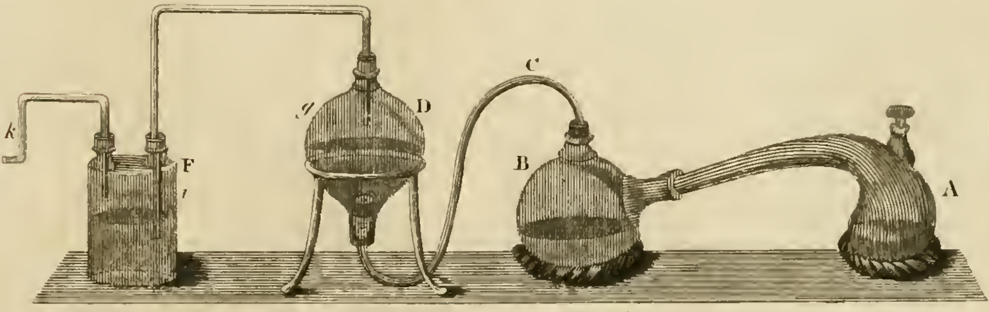

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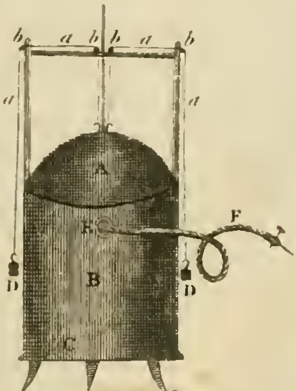

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CHEMNITZ, Martin, a famous Lutheran divine, the diſciple of Melancthon, was born at Britzen in Brandenburg, in 1522. He was employed in ſeveral important negociations by the princes of the ſame communion; and died in 1589. His principal work is the examen of the Council of Trent, in Latin.

CHEMOSH. See Chamos.

CHEMOSIS, a diſeaſe of the eyes, proceeding from an inflammation; wherein the white of the eye ſwells above the black, and overtops it to ſuch a degree, that there appears a ſort of gap between them. Others define it to be an elevation of the membrane which ſurrounds the eye, and is called the *white;* being an affection of the eye, like white fleſh.

CHENOPODIUM, Goose-Foot, or *Wild Orach:* See Botany *Index*.

CHEPELIO, an iſland in the bay of Panama and province of Darien, in South America, ſituated about three leagues from the city of Panama, which it ſupplies with proviſions. W. Long. 81. N. Lat. 9.

CHEPSTOW, a market town of Monmouthſhire in England, ſeated on the river Wye near its mouth, in W. Long. 2. 40. N. Lat. 51. 40.

CHEQ, or Cherif, the prince of Mecca, who is, as it were, high-prieſt of the law, and ſovereign pontiff of all the Mahometans of whatever ſect or country they be. See Caliph.

The grand ſignior, ſophis, moguls, khans of Tartary, &c. ſend him yearly preſents, eſpecially tapeſtry to cover Mahomet's tomb withal, together with a ſumptuous tent for himſelf, and vaſt ſums of money to provide for all the pilgrims during the 17 days of their devotion.

CHERASCO, a ſtrong and conſiderable town of Italy, in Piedmont, and capital of a territory of the ſame name, with a ſtrong citadel, belonging to the king of Sardinia, where he retired in 1706, during the ſiege of Turin. It is ſeated at the confluence of the rivers Sturia and Tanaro, upon a mountain. E. Long. 7. 55. N. Lat. 44. 35.

CHERBURG, a ſea-port town of France, in Normandy, with a harbour and Auguſtine abbey. It is remarkable for the ſea-fight between the Engliſh and French fleets in 1692, when the latter were beat, and upwards of twenty of their men of war burnt near Cape la Hogue. The Britiſh landed here in Auguſt 1758, and took the town, with the ſhips in the baſon, demoliſhed the fortifications, and ruined the other works which had been long carried on for enlarging the harbour and rendering it more ſafe and convenient. Within theſe few years it has been attempted again to improve the harbour, and rebuild the works; but after conſiderable progreſs had been made, a great part of them ſuddenly gave way, and the enterpriſe it is thought will not be again reſumed. E. Long. 1. 38. N. Lat. 49. 38.

CHEREM, among the Jews, is uſed to ſignify a ſpecies of annihilation. See Annihilation.

The Hebrew word *cherem*, ſignifies properly to *deſtroy, exterminate, devote,* or *anathematiſe.*

Cherem is likewiſe ſometimes taken for that which is conſecrated, vowed, or offered to the Lord, ſo that it may no longer be employed in common or profane uſes. No devoted thing that a man ſhall devote unto the Lord, of all that he hath of man and beaſt, and of the field of his poſſeſſion, ſhall be ſold or redeemed; every devoted thing is moſt holy to the Lord: none devoted, which ſhall be devoted of men, ſhall be redeemed, but ſhall ſurely be put to death. There are ſome who aſſert that the perſons thus devoted were put to death; whereof Jephtha's daughter is a memorable example. Judges xi. 29. &c.

Cherem is alſo uſed for a kind of excommunication in uſe among the Jews. See Niddui.

CHERESOUL, or Chahrzul, a town in Turkey in Aſia, capital of Curdiſtan, and the ſeat of a beglerbeg. E. Long. 45. 15. N. Lat. 36. 0.

CHERILUS, of Samos, a Greek poet, flouriſhed 479 years before Chriſt. He ſung the victory gained by the Athenians over Xerxes, and was rewarded with a piece of gold for every verſe. His poem had afterwards the honour of being rehearſed yearly with the works of Homer.

CHERLERIA. See Botany *Index*.

CHERLESQUIOR, in Turkiſh affairs, denotes a lieutenant general of the grand ſignior's armies.

CHERMES, in *Zoology*, a genus of inſects belonging to the order of inſecta hemiptera. See Entomology *Index*.

Chermes Mineral. See Kermes.

CHERRY-island, an iſland in the northern ocean; lying between Norway and Greenland, in E. Long. 20. 5. N. Lat. 75. 0.

Cherry-Tree. See Prunus, Botany *Index*.

CHERSO, an iſland in the gulf of Venice, with a town, of the ſame name near Croatia, belonging to the Venetians. The air is good, but the ſoil ſtony; however, it abounds in wine, cattle, oil, and excellent honey. E Long. 15. 5. N. Lat. 45. 8.

CHERSONESUS, among modern geographers, the ſame with a peninſula; or a continent almoſt encompaſſed round with the ſea, only joining to the main land by a narrow neck or iſthmus. The word is Greek χερσονησος; of χερσος, *land*, and νησος, *iſland;* which ſignifies the ſame. In ancient geography, it was applied to ſeveral peninſulas; as the Cherſoneſus Aurea, Cimbrica, Taurica, and Thracica, now thought to be Malacca, Jutland, Crim Tartary, and Romania.

CHERT, Petrosilex, *Lapis Corneus*, the *Hornſtein* of the Germans. See Mineralogy *Index*.

CHERTZEY, a market town of Surrey in England, about ſeven miles weſt from Kingſton upon Thames. W. Long. 30. N. Lat. 51. 25.

CHERUB, (plural, Cherubim); a celeſtial ſpirit, which in the hierarchy is placed next to the ſeraphim. See Hierarchy.

The term *cherub*, in Hebrew, is ſometimes taken for a calf or ox. Ezekiel ſets down the face of the cherub as ſynonymous to the face of an ox. The word *cherub*, in Syriac and Chaldee, ſignifies to *till* or *plow*, which is the proper work of oxen. Cherub alſo ſignifies *ſtrong* and *powerful*. Grotius ſays, that the cherubim were figures much like that of a calf. Bochart thinks likewiſe, that the cherubim were more like to the figure of an ox than to any thing beſides; and Spencer is of the ſame opinion. Laſtly, St John, in the Revelation, calls cherubim *beaſts*. Joſephus ſays the cherubim were extraordinary creatures, of a figure unknown to mankind. Clemens of Alexandria believes,

lieves, that the Egyptians imitated the cherubim of the Hebrews in the repreſentations of their ſphinxes and their hieroglyphical animals. All the ſeveral deſcriptions, which the ſcripture gives us of cherubim, differ from one another; but all agree in repreſenting them as a figure compoſed of various creatures, as a man, an ox, an eagle, and a lion. Such were the cherubim deſcribed by Ezekiel. Thoſe which Iſaiah ſaw, and are called *ſeraphim* by him, had the figure of a man with ſix wings; with two whereof they covered their faces, with two more they covered their feet, and with the two others they flew. Thoſe which Solomon placed in the temple at Jeruſalem are ſuppoſed to have been nearly of the ſame form. Thoſe which St John deſcribes in the Revelations were all eyes before and behind, and had each ſix wings. The firſt was in the form of a lion, the ſecond in that of a calf, the third of a man, and the fourth of an eagle. The figure of the cherubim was not always uniform, ſince they are differently deſcribed in the ſhapes of men, eagles, oxen, lions, and in a compoſition of all theſe figures put together. Moſes likewiſe calls theſe ſymbolical or hieroglyphical repreſentations, which were embroidered on the veils of the tabernacle, *cherubim* of coſtly work. Such were the ſymbolical figures which the Egyptians placed at the gates of their temples and the images of the generality of their gods, which were commonly nothing but ſtatues compoſed of men and animals.

CHERVIL. See Chærophyllum, Botany *Index*.

CHESAPEAK, in America, one of the largeſt bays in the known world. Its entrance is between Cape Charles and Cape Henry in Virginia, 12 miles wide; and it extends 270 miles to the northward, dividing Virginia and Maryland. Through this extent it is from 7 to 18 miles broad, and generally about 9 fathoms deep; affording many commodious harbours, and a ſafe and eaſy navigation. It receives the waters of the Suſquehannah, Potomak, Rappahannock, York, and James rivers, which are all large and navigable.

CHESELDEN, William, an eminent anatomiſt and ſurgeon, was born at Burrow on the Hill, in the county of Leiceſter, deſcended from an ancient family in the county of Rutland, whoſe arms and pedigree are in Wright's "Hiſtory of Rutland." He received the rudiments of his profeſſional ſkill at Leiceſter; and married Deborah Knight, a citizen's daughter, by whom he had one daughter, Williamina Deborah. In 1713 he publiſhed his Anatomy of the Human Body, one volume 8vo; and in 1723, A Treatiſe on the High Operation for the Stone. He was one of the earlieſt of his profeſſion who contributed by his writings to raiſe it to its preſent eminence. In the beginning of 1736, he was thus honourably mentioned by Mr Pope: "As ſoon as I had ſent my laſt letter, I received a moſt kind one from you, expreſſing great pain for my late illneſs at Mr Cheſelden's. I conclude you was eaſed of that friendly apprehenſion in a few days after you had diſpatched your's, for mine muſt have reached you then. I wondered a little at your query, Who Cheſelden was? It ſhows that the trueſt merit does not travel ſo far any way as on the wings of poetry: he is the moſt noted and moſt deſerving man in the whole profeſſion of chirurgery; and has ſaved the lives of thouſands by his manner of cutting for the ſtone." He appears to have been on terms of the moſt intimate friendſhip with Mr Pope, who frequently, in his Letters to Mr Richardſon, talks of dining with Mr Cheſelden, who then lived in or near Queen Square. In February 1737, Mr Cheſelden was appointed ſurgeon to Chelſea hoſpital. As a governor of the Foundling Hoſpital, he ſent a benefaction of 50l. to that charity, May 7. 1751, incloſed in a paper with the following lines:

> 'Tis what the happy to th' unhappy owe;
> For what man gives, the gods by him beſtow. Pope.

He died at Bath, April 11. 1752, of a diſorder ariſing from drinking ale after eating hot buns. Finding himſelf uneaſy, he ſent for a phyſician, who adviſed vomiting immediately; and if the advice had been taken, it was thought his life might have been ſaved. By his direction, he was buried at Chelſea.

CHESHIRE, a maritime county of England, bounded by Lancaſhire on the north; Shropſhire and part of Flintſhire, on the ſouth; Derbyſhire and Staffordſhire, on the eaſt and ſouth-eaſt; and Denbighſhire, and part of Flintſhire, on the weſt and north-weſt. It extends in length about 44 miles, in breadth 25; and is ſuppoſed to contain 125,000 inhabitants. Both the air and ſoil in general are good. In many places of the country are peat-moſſes, in which are often found trunks of fir-trees, ſometimes ſeveral feet under ground, that are uſed by the inhabitants both for fuel and candles. Here alſo are many lakes and pools well ſtored with fiſh; beſides the rivers Merſey, Weaver, and Dee, which laſt falls into a creek of the Iriſh ſea near Cheſter. This county alſo abounds with wood: but what it is chiefly remarkable for, is its cheeſe, which has a peculiar flavour, generally thought not to be inferior to any in Europe; (ſee Cheese). The principal towns are, Cheſter the capital, Cholmondely, Namptwitch, &c.

William the Conqueror erected this county into a palatinate, or county palatine, in favour of his nephew Hugh Lupus, to whom he granted the ſame ſovereignty and juriſdiction in it that he himſelf had in the reſt of the iſland. By virtue of this grant, the town of Cheſter enjoyed ſovereign juriſdiction within its own precincts; and that in ſo high a degree, that the earls held parliaments, conſiſting of their barons and tenants, which were not bound by the acts of the Engliſh parliament: but the exorbitant power of the palatinates was at laſt reduced by Henry VIII.; however, all caſes and crimes, except thoſe of error, foreign plea, foreign voucher, and high-treaſon, are ſtill heard and determined within the ſhire. The earls were anciently ſuperiors of the whole county, and all the landholders were mediately or immediately their vaſſals, and under the like ſovereign allegiance to them as they were to the kings of England; but the earldom was united to the crown by Edward III. ſince which time, the eldeſt ſons of kings of England have always been earls of Cheſter, as well as princes of Wales. Cheſhire ſends four members to parliament; two for the county, and two for the capital.

CHESNE, Andrew du, ſtyled the father of French hiſtory, was born in 1584. He wrote, 1. A hiſtory of the popes. 2. A hiſtory of England. 3. An inquiry into the antiquities of the towns of France. 4. A hiſtory of the cardinals. 5. A bibliotheca of the authors who have written the hiſtory and topography of France, &c. He was cruſhed to death by a cart, in going from Paris to his country houſe at Verriere, in 1640.

CHESNUT-TREE. See Fagus, Botany *Index*.

CHESS, an ingenious game performed with different pieces of wood, on a board divided into 64 ſquares or houſes; in which chance has ſo ſmall a ſhare, that it may be doubted whether a perſon ever loſt a game but by his own fault.

Each gameſter has eight dignified pieces, viz. a king, a queen, two biſhops, two knights, and two rooks, alſo eight pawns: all which, for diſtinction's ſake, are painted of two different colours, as white and black.

As to their diſpoſition on the board, the white king is to be placed on the fourth black houſe from the corner of the board, in the firſt and lower rank; and the black king is to be placed on the fourth white houſe on the oppoſite, or adverſary's, end of the board. The queens are to be placed next to the kings, on houſes of their own colour. Next to the king and queen, on each hand, place the two biſhops; next to them, the two knights; and laſt of all, on the corners of the board, the two rooks. As to the pawns, they are placed, without diſtinction, on the ſecond rank of the houſe, one before each of the dignified pieces.

Having thus diſpoſed the men, the onſet is commonly begun by the pawns, which march ſtraight forward in their own file, one houſe at a time, except the firſt move, when it can advance two houſes, but never moves backwards: the manner of their taking the adverſary's men is ſidewiſe, in the next houſe forwards; where having captivated the enemy, they move forward as before. The rook goes forward or croſswiſe through the whole file, and back again. The knight ſkips backward and forward to the next houſe, ſave one, of a different colour, with a ſideling march, or a ſlope, and thus kills his enemies that fall in his way, or guards his friends that may be expoſed on that ſide. The biſhop walks always in the ſame colour of the field that he is placed in at firſt, forward and backward, aſlope, or diagonally, as far as he liſts. The queen's walk is more univerſal, as ſhe takes all the ſteps of the before-mentioned pieces, excepting that of the knight; and as to the king's motion, it is one houſe at a time, and that either forward, backward, ſloping, or ſidewiſe.

As to the value of the different pieces, next to the king is the queen, after her the rooks, then the biſhops, and laſt of the dignified pieces comes the knight. The difference of the worth of pawns, is not ſo great as that of noblemen; only, it muſt be obſerved, that the king's biſhop's pawn is the beſt in the field, and therefore the ſkilful gameſter will be careful of him. It ought alſo to be obſerved, that whereas any man may be taken, when he falls within the reach of any of the adverſary's pieces, it is otherwiſe with the king, who, in ſuch a caſe, is only to be ſaluted with the word *check*, warning him of his danger, out of which it is abſolutely neceſſary that he move; and if it ſo happen that he cannot move without expoſing himſelf to the like inconveniency, it is check-mate, and the game is loſt. The rules of the game are,

1. In order to begin the game, the pawns muſt be moved before the pieces, and afterwards the pieces muſt be brought out to ſupport them. The king's, queen's, and biſhop's pawns, ſhould be moved firſt, that the game may be well opened; the pieces muſt not be played out early in the game, becauſe the player may thereby loſe his moves: but above all, the game ſhould be well arranged before the queen is played out. Uſeleſs checks ſhould alſo be avoided, unleſs ſome advantage is to be gained by them, becauſe the move may be loſt, if the adverſary can either take or drive the piece away.

2. If the game is crowded, the player will meet with obſtructions in moving his pieces; for which reaſon he ſhould exchange pieces or pawns, and caſtle (A) his king as ſoon as it is convenient, endeavouring at the ſame time to crowd the adverſary's game, which may be done by attacking his pieces with the pawns, if the adverſary ſhould move his pieces out too ſoon.

3. The men ſhould be ſo guarded by one another, that if a man ſhould be loſt, the player may have it in his power to take one of the adverſary's in return; and if he can take a ſuperior piece in lieu of that which he loſt, it would be an advantage, and diſtreſs the adverſary.

4. The adverſary's king ſhould never be attacked without a force ſufficient; and if the player's king ſhould be attacked without having it in his power to attack the adverſary's, he ſhould offer to make an exchange of pieces, which may cauſe the adverſary to loſe a move.

5. The board ſhould be looked over with attention, and the men reconnoitred, ſo as to be aware of any ſtroke that the adverſary might attempt in conſequence of his laſt move. If, by counting as many moves forward as poſſible, the player has a proſpect of ſucceſs, he ſhould not fail doing it, and even ſacrifice a piece or two to accompliſh his end.

6. No man ſhould be played till the board is thoroughly examined, that the player may defend himſelf againſt any move the adverſary has in view; neither ſhould any attack be made till the conſequences of the adverſary's next move are conſidered; and when an attack may with ſafety be made, it ſhould be purſued without catching at any bait that might be thrown out in order for the adverſary to gain a move, and thereby cauſe the deſign to miſcarry.

7. The queen ſhould never ſtand in ſuch a manner before the king, that the adverſary, by bringing a rook or biſhop, could check the king if ſhe were not there; as it might be the loſs of the queen.

(A) *Caſtle his king*, is to cover the king with a caſtle; which is done by a certain move which each player has a right to whenever he thinks proper.

8. The adverſary's knight ſhould never be ſuffered to check the king and queen, or king and rook, or queen and rook, or the two rooks at the ſame time; eſpecially if the knight is properly guarded: becauſe, in the two firſt caſes, the king being forced to go out of check, the queen or the rook muſt be loſt; and in the two laſt caſes a rook muſt be loſt at leaſt for a worſe piece.

9. The player ſhould take care that no guarded pawn of the adverſary's fork two of his pieces.

10. As ſoon as the kings have caſtled on different ſides of the board, the pawns on that ſide of the board ſhould be advanced upon the adverſary's king, and the pieces, eſpecially the queen and rook, ſhould be brought to ſupport them; and the three pawns belonging to the king that is caſtled muſt not be moved.

11. The more moves a player can have as it were in ambuſcade, the better; that is to ſay, the queen, biſhop, or rook, is to be placed behind a pawn or a piece, in ſuch a poſition as that upon playing that pawn or piece a check is diſcovered upon the adverſary's king, by which means, a piece or ſome advantage is often gained.

12. An inferior piece ſhould never be guarded with a ſuperior, when a pawn would anſwer the ſame purpoſe; for this reaſon, the ſuperior piece may remain out of play; neither ſhould a pawn be guarded with a piece when a pawn would do as well.

13. A well-ſupported pawn that is paſſed often coſts the adverſary a piece; and when a pawn or any other advantage is gained without endangering the loſs of the move, the player ſhould make as frequent exchanges of pieces as he can. The advantage of a paſſed pawn is this: for example, if the player and his adverſary have each three pawns upon the board, and no piece, and the player has one of his pawns on one ſide of the board, and the other two on the other ſide, and the adverſary's three pawns are oppoſite to the player's two pawns, he ſhould march with his king as ſoon as he can, and take the adverſary's pawns: If the adverſary goes with his king to ſupport them, the player ſhould go on to queen with his ſingle pawns; and then if the adverſary goes to hinder him, he ſhould take the adverſary's pawns, and move the others to queen (B).

14. When the game is near finiſhed, each party having only three or four pawns on each ſide of the board, the kings muſt endeavour to gain the move in order to win the game. For inſtance, when the player brings his king oppoſite to the adverſary's with only one ſquare between, he will gain the move.

15. If the adverſary has his king and one pawn on the board, and the player has only his king, he cannot loſe the game, provided he brings his king oppoſite to the adverſary's, when the adverſary is directly before or on one ſide of his pawn, and there is only one ſquare between the kings.

16. If the adverſary has a biſhop and one pawn on the rook's line, and this biſhop is not of the colour that commands the corner ſquare the pawn is going to, and the player has only his king, if he can get into that corner, he cannot loſe; but, on the contrary, may win by a ſtale (c).

17. If the player has greatly the diſadvantage of the game, having only his queen left in play, and his king happens to be in a poſition to win, as above-mentioned, he ſhould keep giving check to the adverſary's king, always taking care not to check him where he can interpoſe any of his pieces that make the ſtale; by ſo doing he will at laſt force the adverſary to take his queen, and then he will win the game by being in a ſtale-mate.

18. The player ſhould never cover a check with a piece that a pawn puſhed upon it may take, for fear of getting only the pawn in exchange for the piece.

19. A player ſhould never crowd his adverſary up with pieces, for fear of giving a ſtale-mate inadvertently, but always ſhould leave room for his king to move.

By way of corroborating what has been already ſaid with reſpect to this game, it is neceſſary to warn a player againſt playing a timid game. He ſhould never be too much afraid of loſing a rook for an inferior piece; becauſe, although a rook is a better piece than any other except the queen, it ſeldom comes into play to be of any great uſe till at the end of the game; for which reaſon it is often better to have an inferior piece in play, than a ſuperior one to ſtand ſtill, or moving to no great purpoſe. If a piece is moved, and is immediately drove away by a pawn, it may be reckoned a bad move, becauſe the adverſary gains a double advantage over the player, in advancing at the ſame time the other is made to retire; although the firſt move may not ſeem of conſequence between equal players, yet a move or two more loſt after the firſt, makes the game ſcarcely to be recovered.

There never wants for variety at this game, provided the pieces have been brought out regularly; but, if otherwiſe, it often happens that a player has ſcarce any thing to play.

Many indifferent players think nothing of the pawns, whereas three pawns together are ſtrong; but four, which conſtitute a ſquare, with the aſſiſtance of other pieces, well managed, make an invincible ſtrength, and in all probability may produce a queen when very much wanted. It is true, that two pawns with a ſpace between are no better than one; and if there ſhould be three over each other in a line, the game cannot be in a worſe way. This ſhows that the pawns are of great conſequence, provided they are kept cloſe together.

Some middling players are very apt to riſk loſing the game in order to recover a piece: this is a miſtake; for it is much better to give up a piece and attack the enemy in another quarter; by ſo doing, the player has a chance of ſnatching a pawn or two from,

or

(B) *To queen*, is to make a queen; that is, to move a pawn into the adverſary's back row, which is the rule at this game when the original one is loſt.

(c) When the king is blocked up ſo as to have no move at all.

or gaining ſome advantage over the adverſary, whilſt his attention is taken up in purſuing this piece.

If the queen and another piece are attacked at the ſame time, and that by removing the queen the piece muſt be loſt; provided two pieces can be gained in exchange for the queen, the queen ſhould be given up, it being the difference of three pieces, and conſequently more than the value of the queen. By loſing the queen, the game is not thrown into that diſorder which it would otherwiſe have been; in this caſe it would be judicious to give the queen for even a piece, or a pawn or two; it being well known among good players, that he who begins the attack, and cannot maintain it, being obliged to retire, generally loſes the game.

A player ſhould never be fond of changing without reaſon, becauſe the adverſary, if he is a good player, will ruin his ſituation, and gain a conſiderable advantage over him. But rather than loſe a move, when a player is ſtronger than the adverſary, it is good play to change, for he thereby increaſes his ſtrength.

When the game is almoſt drawn to a concluſion, the player ſhould recollect that his king is a capital piece, and conſequently ſhould keep him in motion; by ſo doing, he generally gets the move, and often the game.

As the queen, rook, and biſhop, operate at a diſtance, it is not always neceſſary in the attack to have them near the adverſary's king.

If a man can be taken with different pieces, the player ſhould take his time, and conſider which of thoſe pieces is the beſt to take it with.

If a piece can be taken almoſt at any time, the player ſhould not be in a hurry about it, but try to make a good move elſewhere before he take it.

A player ſhould be cautious how he takes his adverſary's pawn with his king, as it often happens to be a ſafeguard to it.

After all that has been ſaid, it is ſtill neceſſary for us to adviſe thoſe who would play well at this game, to be very cool and attentive to the matter in queſtion: for it is impoſſible that any perſon in the univerſe can be capable of playing at cheſs if their thoughts are employed elſewhere. The laws at this game are,

1. If a player touches his man, he muſt play it; and if he quits it, he cannot recal it.

2. If by miſtake or otherwiſe a falſe move is played, and the adverſary takes no notice of it till he hath played his next move, it cannot be recalled by either of the parties.

3. If a player miſplaces the men, and he plays two moves, it is at the option of the adverſary to permit him to begin the game or not.

4. If the adverſary plays or diſcovers a check to a player's king, and give no notice of it, the player may let him ſtand ſtill till he does.

5 After the king is moved, a player cannot caſtle.

Saraſin has an expreſs treatiſe on the different opinions of the origin of the Latin *ſchacchi*, whence the French *ethecs*, and our *cheſs*, is formed. Menage is alſo very full on the ſame head. Leunclavius takes it to come from *Uſcoches*, famous Turkiſh robbers: P. Sirmond, from the German *ſcache*, "theft;" and that from *calculus*. He takes *cheſs* to be the ſame with the *ludus latrunculorum* of the Romans, but miſtakenly. This opinion is countenanced by Voſſius and Salmaſius, who derive the word from *calculus*, as uſed for *latrunculus*. G. Toloſanus derives it from the Hebrew, *ſcarch, valavit, et mat mortuus*; whence *check* and *checkmate*. Fabricius ſays, a celebrated Perſian aſtronomer, one Schatrenſcha, invented the game of *cheſs*; and gave it his own name, which it ſtill bears in that country. Nicod derives it from *ſchecque*, or *xeque*, a Mooriſh word for lord, king, and prince. Bochart adds that *ſcach* is originally Perſian; and that *ſcachmat* in that language, ſignifies the king is dead.—The opinion of Nicod and Bochart, which is likewiſe that of Scriverius, appears the moſt probable.

Mr Twiſs mentions a ſmall treatiſe on cheſs, written as he ſuppoſes, about 400 years ago; at the end of which is a repreſentation of a round cheſs-board, with directions for placing the men upon it. In this the knight can cover the 64 ſquares on the board at as many moves. The board is divided into theſe 64 parts by four concentric circles, having an empty ſpace in the middle; and each of theſe is divided into 16 parts. Number 1 is placed in the outermoſt circle; number 2 in the third circle counting inwards, in the diviſion to the right hand of the former; number 3 is placed in the outermoſt circle, in the diviſion to the right hand of 2; 4 in the third circle counting inwards to the right hand of three; and thus alternately from the firſt to the third, and from the third to the firſt circle, till the round is completed by 16 on the third circle to the left hand of 1. Number 17 is then placed on the diviſion of the innermoſt circle to the right hand of 1; 18 on the ſecond circle counting inwards, to the right hand of 17; and thus alternately from the fourth to the ſecond, and from the ſecond to the fourth circles, until the round is completed by 32, directly below number 1. Number 33 then is placed on the third circle directly to the right hand of number 2; 34 on the fourth circle, to the right hand of 4; and thus alternately between the third and fourth circles, until the round is again completed by 48 on the fourth circle, directly below number 33. The numbers are now placed in a retrograde faſhion; 50 on the outer circle in that diviſion immediately to the right hand of 1; 51 on the third circle, to the left hand of 2; and directly below number 32; 52 is then placed on the outer circle, immediately on the left hand of 1; 53 on the third circle directly to the left hand of 16; and thus alternately on the firſt and third circles, until the laſt ground is completed by 64 between the number 3 and 5. On this round cheſs-board, ſuppoſing the black king to be placed in number 48 on the fourth circle, the queen ſtands on number 17 at his left hand; the biſhops in 33 and 2; the knights 18 and 47; the caſtles in 3 and 50; the pawns on 19, 4, 49, 64, and 46, 51, 32, 1. The white king will then ſtand in 25, oppoſite to the black queen; the white queen in 40 oppoſite to the black king, and ſo on. In playing on a board of this kind, it will be found, that the power of the caſtle is double to that in the common game, and that of the biſhop only one half; the former having 16 ſquares to range in, and the laſt only four. The king can caſtle only one way; and it is very difficult to bring the game to a concluſion.

With regard to the origin of the game at cheſs, we are much in the dark. Though it came to us from the Saracens, it is by no means probable that they were the original inventors of it. According to ſome, it was invented by the celebrated Grecian hero Diomedes. Others ſay, that two Grecian brothers, Ledo and Tyrrheno, were the inventors; and that being much preſſed with hunger, they ſought to alleviate the pain by this amuſement.

According to Mr Irwin it is a game of Chineſe invention. During his reſidence in India, he found that a tradition of this nature exiſted among the Bramins, with whom he frequently played the game. While he was at Canton in 1793, he gives the following account of the information which he acquired relative to the origin of the game of cheſs. ‘ A young mandarin, of the profeſſion of arms, having an inquiſitive turn, was my frequent viſitor; and, what no queſtions could have drawn from him, the accidental ſight of an Engliſh cheſs-board effected. He told me, that the Chineſe had a game of the ſame nature; and, on his ſpecifying a difference in the pieces and board, I perceived, with joy, that I had diſcovered the deſideratum of which I had been ſo long in ſearch. The very next day my mandarin brought me the board and equipage; and I found, that the Bramins were neither miſtaken touching the board, which has a river in the middle to divide the contending parties, nor in the powers of the king, who is entrenched in a fort, and moves only in that ſpace, in every direction. But, what I did not before hear, nor do I believe is known out of this country, there are two pieces, whoſe movements are diſtinct from any in the Indian or European game. The mandarin, which anſwers to our biſhop, in his ſtation and ſidelong courſe, cannot, through age, croſs the river; and a rocket-boy, ſtill uſed in the Indian armies, who is ſtationed between the lines of each party, acts literally with the motion of the rocket, by vaulting over a man, and taking his adverſary at the other end of the board. Except that the king has his two ſons to ſupport him, inſtead of a queen, the game, in other reſpects, is like ours; as will appear in the plan of the board and pieces I have the honour to encloſe, together with directions to place the men and play the game.

“ As the young man who had diſcovered this to me was of a communicative and obliging diſpoſition, and was at this time purſuing his ſtudies in the college of Canton, I requeſted the favour of him to conſult ſuch ancient books as might give ſome inſight into the period of the introduction of cheſs into China; to confirm, if poſſible, the idea that ſtruck me of its having originated here. The acknowledged antiquity of this empire, the unchangeable ſtate of her cuſtoms and manners, beyond that of any other nation in the world; and more eſpecially the ſimplicity of the game itſelf, when compared to its compaſs and variety in other parts, appeared to give a colour to my belief. That I was not diſappointed in the event, I have no doubt will be allowed, on the peruſal of the tranſlation of a manuſcript extract, which my friend Tinqua brought me, in compliance with my deſire; and which, accompanied by the Chineſe manuſcript, goes under cover to your lordſhip. As the mandarin ſolemnly aſſured me that he took it from the work quoted, and the tranſlation has been as accurately made as poſſible, I have no heſitation to deliver the papers as authentic.

“ From theſe premiſes I have therefore ventured to make the following inferences:—That the game of cheſs is probably of Chineſe origin. That the confined ſituation and powers of the king, reſembling thoſe of a monarch in the earlier parts of the world, countenance this ſuppoſition; and that, as it travelled weſtward, and deſcended to later times, the ſovereign prerogative extended itſelf, until it became unlimited, as in our ſtate of the game. That the agency of the princes, in lieu of the queen, beſpeaks forcibly the nature of the Chineſe cuſtoms, which exclude females from all power or influence whatever; which princes, in its paſſage through Perſia, were changed into a ſingle vizier, or miniſter of ſtate, with the enlarged portion of delegated authority that exiſts there; inſtead of whom, the European nations, with their uſual gallantry, adopted a queen on the board (D). That the river between the parties is expreſſive of the general face of the country, where a battle could hardly be fought without encountering an interruption of this kind, which the ſoldier was here taught to overcome; but that, on the introduction of the game into Perſia, the board changed with the dry nature of the region, and the conteſt was decided on terra firma. And laſtly, that in no account of the origin of cheſs, that I have read, has the tale been ſo characteriſtic or conſiſtent as that which I have the honour to offer to the Iriſh academy. With the Indians, it was deſigned by a Bramin to cure the melancholy of the daughter of a rajah. With the Perſians, my memory does not aſſiſt me to trace the fable; though, if it were more to the purpoſe, I think I ſhould have retained it. But, with the Chineſe, it was invented by an experienced ſoldier, on the principles of war. Not to diſpel love-ſick vapours, or inſtruct a female in a ſcience that could neither benefit nor inform her; but to quiet the murmurs of a diſcontented ſoldiery; to employ their vacant hours in leſſons on the military art, and to cheriſh the ſpirit of conqueſt in the boſom of winter-quarters. Its age is traced by them on record near two centuries before the Chriſtian era; and among the numerous claims for this noble invention, that of the Chineſe, who call it by way of diſtinction, *chong kè* or *the royal game*, appears alone to be indiſputable.”

Tranſlation of an Extract from the Concum, or Chineſe Annals, reſpecting the Invention of the Game of Cheſs, delivered to me by Tinqua, a Soldier Mandarin of the Province of Fokien.

“ Three hundred and ſeventy nine years after the time

(D) That on the acquiſition of ſo ſtrong a piece as the vizier, the paö were ſuppreſſed, this as poſſeſſing powers unintelligible, at that time, to other nations; and three pawns added, in conſequence to make up the number of men; and that as diſcipline improved, the lines, which are ſtraggling on the Chineſe board, might have been cloſed on ours.

time of Confucius, or one thouſand nine hundred and ſixty-five years ago, Hung Cochu, king of Kiangnan, ſent an expedition into the Shenſi country, under the command of a mandarin, called Hanſing, to conquer it. After one ſucceſsful campaign, the ſoldiers were put into winter quarters; where, finding the weather much colder than what they had been accuſtomed to, and being alſo deprived of their wives and families, the army, in general, became impatient of their ſituation, and clamorous to return home. Hanſing, upon this, revolved in his mind the bad conſequences of complying with their wiſhes. The neceſſity of ſoothing his troops, and reconciling them to their poſition, appeared urgent, in order to finiſh his operations in the enſuing year. He was a man of genius, as well as a good ſoldier; and having contemplated ſome time on the ſubject, he invented the game of cheſs, as well for an amuſement to his men in their vacant hours, as to inflame their military ardour, the game being wholly founded on the principles of war. The ſtratagem ſucceeded to his wiſh. The ſoldiery were delighted with the game; and forgot, in their daily conteſts for victory, the inconveniences of their poſt. In the ſpring the general took the field again; and, in a few months, added the rich country of Shenſi to the kingdom of Kiangnan, by the defeat and capture of its king, Choupayuen, a famous warrior among the Chineſe. On this conqueſt Hung Cochu aſſumed the title of emperor, and Choupayuen put an end to his own life in deſpair.

Explanation of the Poſition, Powers and Moves of the Pieces on the Chineſe Cheſs-board, or Chong Ke. (Royal Game).

“ As there are nine pieces inſtead of eight, to occupy the rear rank, they ſtand on the lines between, and not within, the ſquares. The game is conſequently played on the lines.

“ The king, or chong, ſtands in the middle line of this row. His moves reſemble thoſe of our king, but are confined to the fortreſs marked out for him.

“ The two princes, or ſou, ſtand on each ſide of him, and have equal powers and limits.

“ The mandarins, or tchong, anſwer to our biſhops, and have the ſame moves, except that they cannot croſs the water or white ſpace in the middle of the board to annoy the enemy, but ſtand on the defenſive.

“ The knights, or rather horſes called *mā̄ā*, ſtand and move like ours in every reſpect.

“ The war-chariots, to tchè, reſemble our rooks or caſtles.

“ The rocket-boys or paö, are pieces whoſe motions and powers were unknown to us. They act with the direction of a rocket, and can take none of their adverſary's men that have not a piece or pawn intervening. To defend your men from this attack, it is neceſſary to open the line between, either to take off the check on the king, or to ſave a man from being captured by the paö. Their operation is, otherwiſe, like that of the rook. Their ſtations are marked between the pieces and pawns.

“ The five pawns, or ping, make up the number of the men equal to that of our board. Inſtead of taking ſideways, like ours, they have the rook's motion, except that it is limited to one ſtep, and is not retrograde. Another important point, in which the ping differs from ours, is that they continue in *ſtatu quo*, after reaching their adverſary's head quarters. It will appear, however, that the Chineſe pieces far exceed the proportion of ours; which occaſions the whole force of the conteſt to fall on them, and thereby precludes the beauty and variety of our game, when reduced to a ſtruggle between the pawns, who are capable of the higheſt promotion, and often change the fortune of the day. The poſts of the ping are marked in front *.”

But according to Sir William Jones, this game is of Hindoo invention. “ If evidence were required to prove this fact (ſays he †), we may be ſatisfied with the teſtimony of the Perſians, who, though as much inclined as other nations to appropriate the ingenious inventions of a foreign people, unanimouſly agree that the game was imported from the weſt of *India* in the ſixth century of our era. It ſeems to have been immemorially known in *Hindoſtan* by the name of *Cheturanga*, i. e. the four *angá's*, or members of any army; which are theſe, *elephants*, *horſes*, *chariots*, and *foot ſoldiers*; and in this ſenſe the word is frequently uſed by epic poets in their deſcription of real armies. By a natural corruption of the pure Sanſcrit word, it was changed by the old Perſians into *Chetrang*; but the Arabs, who ſoon after took poſſeſſion of their country, had neither the initial nor final letter of that word in their alphabet, and conſequently altered it further into *Shetranj*, which found its way preſently into the modern *Perſian*, and at length into the dialects of India, where the true derivation of the name is known only to the learned. Thus has a very ſignificant word in the ſacred language of the Brahmins been transformed by ſucceſſive changes into *axedrez*, *ſcacchi*, *échecs*, *cheſs*, and, by a whimſical concurrence of circumſtances, has given birth to the Engliſh word *check*, and even a name to the *exchequer* of Great Britain.”

It is confidently aſſerted, that Sanſcrit books on *cheſs* exiſt in Bengal; but Sir William had ſeen none of them when he wrote the memoir which we have quoted. He exhibits, however, a deſcription of a very ancient *Indian* game of the ſame kind, but more complex, and in his opinion more modern, than the ſimple cheſs of the *Perſians*. This game is alſo called *Chaturanga*, but more frequently *Chaturaji*, or the *four kings*, ſince it is played by four perſons repreſenting as many princes, two allied armies combating on each ſide. The deſcription is taken from a book called *Bhawiſhya Purán*; in which the form and principal rules of this factitious warfare are thus laid down: “ Eight ſquares being marked on all ſides, the *red* army is to be placed on the eaſt, the *green* to the ſouth the *yellow* to the weſt, and the *black* to the north. Let the *elephant* (ſays the author of the *Purán*) ſtand on the left of the *king*; next to him the *horſe*; then the *boat*; and before them all, four *foot ſoldiers*; but the *boat* muſt be placed in the angle of the board.”

“ From this paſſage (ſays the preſident) it clearly appears, that an army with its four *angás* muſt be placed on each ſide of the board, ſince an *elephant* could not ſtand, in any other poſition, on the left hand of each *king*; and Radhacant (a Pandit) informed me, that the board conſiſted, like ours, of 64 ſquares, half of them occupied by the forces, and half vacant. He added, that this game is mentioned in the oldeſt law books, and that it was invented by the wife of a king, to amuſe him with an image of war, while his metropolis was beſieged in the ſecond age of the world. A *ſhip* or *boat* is abſurdly ſubſtituted, we ſee, in this complex game, for the *rat'h*, or armed *chariot*, which the *Bengaleſe* pronounce *rot'h*, and which the Perſians changed into *rokh*; whence came the *rook* of ſome European nations; as the *vierge* and *fal* of the French are ſuppoſed to be corruptions of *ferz* and *fil*, the *prime miniſter* and *elephant* of the perſians and Arabs.'

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* *Iriſh Tranſ.* vol. v.

† *Aſiatic Reſearches*, vol. ii. mem. 9.

As fortune is ſuppoſed to have a great ſhare in deciding the fate of a battle, the uſe of dice is introduced into this game to regulate its moves; for (ſays the Purán) "if *cinque* be thrown, the *king* or a *pawn* muſt be moved; if *quatre*, the *elephant*; if *trois*, the *horſe*; and if *deux*, the *boat*. The *king* paſſes freely on all ſides, but over *one* ſquare only; and with the ſame limitation the *pawn* moves, but he advances ſtraight forward, and kills his enemy through an angle. The *elephant* marches in all directions as far as his driver pleaſes; the *horſe* runs obliquely, traverſing the ſquares; and the *ſhip* goes over two ſquares diagonally." The *elephant*, we find, has the powers of our *queen*, as we are pleaſed to call the *general* or *miniſter* of the Perſians; and the *ſhip* has the motion of the piece to which we give the unaccountable appellation of *biſhop*, but with a reſtriction which muſt greatly leſſen its value.

In the *Purán* are next exhibited a few general rules and ſuperficial directions for the conduct of the game. Thus, "the *pawns* and the *ſhip* both kill and may be voluntarily killed; while the *king*, the *elephant*, and the *horſe*, may ſlay the foe, but muſt not expoſe themſelves to be ſlain. Let each player preſerve his own forces with extreme care, ſecuring his *king* above all, and not ſacrificing a ſuperior to keep an inferior piece." Here (ſays the preſident) the commentator on the *Purán* obſerves, that the *horſe*, who has the choice of *eight* moves from any central poſition, muſt be preferred to the *ſhip*, which has only the choice of *four*. But the argument would not hold in common game, where the *biſhop* and *tower* command a whole line, and where a knight is always of leſs value than a tower in action, or the biſhop of that ſide on which the attack is begun. "It is by the overbearing power of the *elephant* (continues the *Purán*) that the king fights boldly; let the whole army therefore, be abandoned in order to ſecure the *elephant*. The king muſt never place one *elephant* before another, unleſs he be compelled by want of room, for he would thus commit a dangerous fault; and if he can ſlay one of two hoſtile elephants, he muſt deſtroy that on his left hand."

What remains of the paſſage which was copied from Sir William Jones, relates to the ſeveral modes in which a partial ſucceſs or complete victory may be obtained by any one of the four players; for, as in a diſpute between two allies, one of the kings may ſometimes aſſume the command of all the forces, and aim at a ſeparate conqueſt. Firſt, "When any one king has placed himſelf on the ſquare of another king (which advantage is called *ſinhaſana* or the *throne*) he wins a ſtake, which is doubled if he kill the adverſe monarch when he ſeizes his place; and if he can ſeat himſelf on the throne of his ally, he takes the command of the whole army." Secondly, "If he can occupy ſucceſſively the thrones of all the three princes, he obtains the victory, which is named *cheturaji*; and the ſtake is doubled if he kill the laſt of the three, juſt before he takes poſſeſſion of his throne; but if he kill him on his throne, the ſtake is quadrupled. Both in giving the *ſinhaſana* and the *cheturaji* the king muſt be ſupported by the *elephants*, or by all the forces united." Thirdly, "When one player has his own king on the board, but the king of his partner has been taken, he may replace his captive ally, if he can ſeize both the adverſe kings; or if he cannot effect their capture, he may exchange his king for one of them, againſt the general rule, and thus redeem the allied prince, who will ſupply his place." This advantage has the name of *nripacriſhta*, or *recovered by the king*. Fourthly, "If a *pawn* can march to any ſquare on the oppoſite extremity of the board, except that of the king, or that of the ſhip, he aſſumes whatever power belonged to that ſquare." Here we find the rule, with a ſlight exception, concerning the advancement of *pawns*, which often occaſions a moſt intereſting ſtruggle at our common cheſs; but it appears that, in the opinion of one ancient writer on the Indian game, this privilege is not allowable when a player has three pawns on the board; but when only one pawn and one ſhip remains, the pawn may advance even to the ſquare of a king or a ſhip, and aſſume the power of either. Fifthly, According to the people of *Lancà*, where the game was invented, "there could be neither victory nor defeat if a king were left on the plain without force; a ſituation which they named *cacacaſht'ha*." Sixthly, "If three ſhips happen to meet, and the fourth ſhip can be brought up to them in the remaining angle, this has the name of *vrihannauca*; and the player of the fourth ſeizes all the others."

The account of this game in the original Sanſcrit is in verſe.

This game was very faſhionable in former times in every part of Europe; though in this country it is not now very common, probably on account of the intenſe application of thought required to play at it. It has long been a favourite of the Icelanders and other northern people. There is little difference between their game and ours.

The game of cheſs has been generally practiſed by the greateſt warriors and generals; and ſome have even ſuppoſed that it was neceſſary for a military man to be well ſkilled in this game. It is a game which has ſomething in it peculiarly intereſting. We read that Tamerlane was a great cheſs-player, and was engaged in a game during the very time of the deciſive battle with Bajazet the Turkiſh emperor, who was defeated and taken priſoner. It is alſo related of Al Amin the caliph of Bagdad, that he was engaged at cheſs with his freedman Kuthar at the time when Al Mamun's forces were carrying on the ſiege of that city with ſo much vigour that it was on the point of being carried by aſſault. Dr Hyde quotes an Arabic hiſtory of the Saracens, in which the caliph is ſaid to have cried out when warned of his danger, Let me alone, for I ſee checkmate againſt Kuthar! We are told that Charles I. was at cheſs when news were brought of the final intention of the Scots to ſell him to the Engliſh; but ſo little was he diſcompoſed by this alarming intelligence,

telligence, that he continued his game with the utmoſt compoſure; ſo that no perſon could have known that the letter he received had given him information of any thing remarkable. King John was playing at cheſs when the deputies from Rouen came to acquaint him that their city was beſieged by Philip Auguſtus; but he would not hear them until he had finiſhed his game.

The following remarkable anecdote we have from Dr Robertſon in his Hiſtory of Charles V. John Frederic, elector of Saxony, having been taken priſoner by Charles, was condemned to death. The decree was intimated to him while at cheſs with Erneſt of Brunſwic, his fellow-priſoner. After a ſhort pauſe, and making ſome reflection on the irregularity and injuſtice of the emperor's proceedings, he turned to his antagoniſt, whom he challenged to finiſh the game. He played with his uſual ingenuity and attention; and having beat Erneſt, expreſſed all the ſatisfaction that is commonly felt on gaining ſuch victories. He was not, however, put to death, but ſet at liberty after five years confinement.

In the Chronicle of the Mooriſh kings of Granada we find it related, that in 1396, Mehemed Balba ſeized upon the crown in prejudice of his elder brother, and paſſed his life in one continual round of diſaſters. His wars with Caſtile were invariably unſucceſsful; and his death was occaſioned by a poiſoned veſt. Finding his caſe deſperate, he diſpatched an officer to the fort of Salabreno to put his brother Juzaf to death, leſt that prince's adherents ſhould form any obſtacle to his ſon's ſucceſſion. The alcayde found the prince playing at cheſs with an *alfaqui* or prieſt. Juzaf begged hard for two hours reſpite, which was denied him; at laſt with great reluctance the officer permitted him to finiſh the game; but before it was finiſhed a meſſenger arrived with the news of the death of Mehemed, and the unanimous election of Juzaf to the crown.

We have a curious anecdote of Ferrand count of Flanders; who having been accuſtomed to amuſe himſelf at cheſs with his wife, and being conſtantly beaten by her, a mutual hatred took place; which came to ſuch a height, that, when the count was taken priſoner at the battle of Bovines, ſhe ſuffered him to remain a long time in priſon, though ſhe could eaſily have procured his releaſe.

The game of cheſs has undergone conſiderable variations ſince it was firſt invented. We have it on good authority, that, among the eaſtern nations, the piece now called the *queen* was formerly called the *vizir* or king's miniſter, and that the powers of the queen herſelf were but very ſmall. The cheſs-boards uſed by Tamerlane were larger, and contained many more ſquares than thoſe at preſent in uſe. Carrera invented two new pieces to be added to the eight commonly in uſe. One of theſe, which he calls *Campione*, is placed between the king's knight and caſtle; the other, named *Centaur*, between the queen's knight and caſtle, has the move of the biſhop and knight united. This invention, however, did not ſurvive its author. In another of this kind, the two additional pieces are called the *centurion* and *decurion;* the former ſituated between the king and his biſhop, in its move the ſame with that of the queen, but only for two ſquares; the latter moves as the biſhop, but only one ſquare at a time. This, like the former, died with its inventor. The cheſs-board of Tamerlane was a parallelogram, having 11 ſquares one way and 12 the other. In the Memoirs of the late Marſhal Keith, we find it related, that he invented an amuſement ſomething ſimilar to that of cheſs, with which the king of Pruſſia was highly entertained. Several thouſand ſmall ſtatues were caſt by a founder; and theſe were ranged oppoſite to each other as if they had been drawn up in an army; making the different movements with them as in real ſervice in the field.

A very complicated kind of game at cheſs was invented by the late duke of Rutland. At this the board has 14 ſquares in breadth, and 10 in height, which make in all 140 houſes: and there are 14 pawns on each ſide, which may move either one, two, or three ſquares the firſt time. The other pieces were the king, queen, two biſhops, two knights, a crowned caſtle uniting the move of the king and caſtle, and a common caſtle. On the other ſide of the king was a *concubine*, whoſe move united that of the caſtle and knight, two biſhops, a ſingle knight, a crowned caſtle, and a common one. In this game the pawns are of very little uſe; and by the extent of the board, the knights loſe much of their value, which conſequently renders the game more defective and leſs intereſting than the common one.

There is an amuſing variety at the game of cheſs, in which the king with eight pawns engages the whole ſet, by being allowed to make two moves for every one of his adverſary. In this he is almoſt certain of coming off victorious; as he can make his firſt move into check, and the ſecond out of it. Thus he can take the queen when ſhe ſtands immediately before her king, and then retreat; for he cannot remain in check. He cannot be check-mated unleſs his adverſary has preſerved his queen and both caſtles.

CHESS-*trees*, *(toquets d'anjure)*; two pieces of wood bolted perpendicularly, one on the ſtarboard, and another on the larboard ſide of the ſhip. They are uſed to confine the *clue*, or lower corners of the main-ſail; for which purpoſe there is a hole in the upper part, through which the rope paſſes that uſually extends the clue of the ſail to windward. See TACK.

The cheſs-trees are commonly placed as far before the main-maſt as the length of the main-beam.

CHEST, in commerce, a kind of meaſure, containing an uncertain quantity of ſeveral commodities.

A cheſt of ſugar, v. g. contains from 10 to 15 hundred weight; a cheſt of glaſs, from two hundred to three hundred feet; of Caſtile ſoap, from two and a half to three hundred weight; of indigo, from one and a half to two hundred weight, five ſcore to the hundred.

CHEST, or *Thorax*. See ANATOMY *Index*.

CHESTER, commonly called *Weſt-Cheſter*, to diſtinguiſh it from many other Cheſters in the kingdom; the capital of Cheſhire in England. It is a very ancient city, ſuppoſed to have been founded by the Romans; and plainly appears to have been a Roman ſtation by the many antiquities which have been and are ſtill diſcovered in and about the town. It was among the laſt places the Romans quitted; and here the Britons maintained their liberty long after the Saxons had got poſſeſſion of the reſt of their country. At preſent it is a large well-built, wealthy city, and carries on a conſiderable trade. Mr Pennant calls it *a city without a parallel*, on account of the ſingular ſtructure of the four principal ſtreets. They are as if excavated out of the earth, and ſunk many feet beneath the ſurface: the carriages drive far beneath the level of the kitchens on a line with ranges of ſhops. The houſes are moſtly of wood, with galleries, piazzas, and covered walls before them; by which not only the ſhops, but thoſe who are walking about the town, are ſo hid, that one would imagine there were ſcarce any inhabitants in it, though it is very populous. But though by this contrivance ſuch as walk the ſtreets are ſcreened from rain, &c. yet the ſhops are thereby rendered dark and inconvenient. The back courts of all the houſes are on a level with the ground; but to go into any of the four principal ſtreets, it is neceſſary to deſcend a flight of ſeveral ſteps.

Cheſter is a biſhops ſee. It was anciently part of the dioceſe of Litchfield; one of whoſe biſhops removing the ſeat of his ſee hither in the year 1075, occaſioned his ſucceſſors to be frequently ſtyled *biſhops of Cheſter*. But it was not erected into a diſtinct biſhopric until the general diſſolution of monaſteries, when King Henry VIII. in the year 1541, raiſed it to this dignity, and allotted the church of the abbey of St Werburg for the cathedral, ſtyling it the *cathedral church of Chriſt and the bleſſed Virgin*; adding the biſhopric to the province of Canterbury: but ſoon after he disjoined it from Canterbury, and added it to the province of York. When this abbey was diſſolved, its revenues were valued at 1003l. 5s. 11d. This dioceſe contains the entire counties of Cheſter and Lancaſter, part of the counties of Weſtmorland, Cumberland, and Yorkſhire, two chapelries in Denbighſhire, and five pariſhes in Flintſhire; amounting in all to 256 pariſhes, of which 101 are impropriations. This biſhopric is valued in the king's books at 420l. 1s. 8d. and is computed to be worth annually 2700l.; the clergy's tenth amounting to 435l. 12s. To this cathedral belong a dean, two archdeacons, a chancellor, a treaſurer, ſix prebendaries, and other inferior officers and ſervants. W. Long. 3. 0. N. Lat. 53. 12.

CHESTER le-Street, the *Cuneaceſtre* of the Saxons; a ſmall thoroughfare town between Newcaſtle and Durham, with a good church and fine ſpire. In the Saxon times this place was greatly reſpected on account of the relicks of St Cuthbert, depoſited here by Biſhop Eardulf, for fear of the Danes, who at that time (about 884) ravaged the country. His ſhrine became afterwards an object of great devotion. King Athelſtan, on his expedition to Scotland, paid it a viſit, to obtain, by interceſſion of the ſaint, ſucceſs on his arms; beſtowed a multitude of gifts on the church; and directed, in caſe he died in his enterpriſe, that his body ſhould be interred there. At the ſame time that this place was honoured with the remains of St Cuthbert, the biſhopric of Lindesfarn was removed here, and endowed with all the lands between the Tyne and the Were, the preſent county of Durham. It was ſtyled *St Cuthbert's patrimony*. The inhabitants had great privileges, and always thought themſelves exempt from all military duty, except that of defending the body of their ſaint. Cheſter-le-Street may be conſidered as the parent of the ſee of Durham: for when the relicks were removed there, the ſee in 995 followed them. Tanner ſays, that probably a chapter of monks, or rather ſecular canons, attended the body at this place from its firſt arrival: but Biſhop Beke, in 1286, in honour of the ſaint, made the church collegiate, and eſtabliſhed here a dean and ſuitable eccleſiaſtics; and, among other privileges, gave the dean a right of fiſhing on the Were, and the tythe of fiſh.

New-CHESTER, a town of Pennſylvania in America, and capital of a county of that name. It is ſeated on the Delawar; and has a fine capacious harbour, admitting veſſels of any burden. W. Long. 74. 7. N. Lat. 40. 15.

CHESTERFIELD, a market-town of Derbyſhire in England, pleaſantly ſituated on a hill between two ſmall rivers. It has the title of an earldom; and a conſiderable market for corn, lead, and other country commodities. The houſes are for the moſt part built of rough ſtone, and covered with ſlate. W. Long. 1. 25. N. Lat. 53. 20.

CHESTERFIELD, *Earl of*. See STANHOPE.

CHEVAL *de* FRISE, a large piece of timber pierced, and traverſed with wooden pikes, armed or pointed with iron, five or ſix feet long. See Plate CXXXVII.

The term is French, and properly ſignifies a *Frieſland horſe*; as having been firſt invented in that country.—It is alſo called a *Turnpike* or *Turniquet*.

Its uſe is to defend a paſſage, ſtop a breach, or make an entrenchment to ſtop the cavalry. It is ſometimes alſo mounted on wheels, with artificial fires, to roll down in an aſſault. Errand obſerves, that the prince of Orange uſed to incloſe his camp with *Chevaux de Friſe*, placing them one over another.

CHEVALER, in the manege, is ſaid of a horſe, when in paſſaging upon a walk or trot, his off fore-leg croſſes or overlaps the near fore-leg every ſecond motion.

CHEVALIER, a French term, ordinarily ſignifying a KNIGHT. The word is formed of the French, *cheval* "horſe," and the barbarous Latin *cavalius*.

It is uſed, in heraldry, to ſignify any *cavalier* or horſeman armed at all points; by the Romans called *cataphractus eques*: now out of uſe, and only to be ſeen in coat-armour.

CHEVAUX *de* FRISE. See *CHEVAL de Friſe*.

CHEVIN, a name uſed in ſome parts of England for the CHUB.

CHEVIOT, or (TIVIOT) HILLS, run from north to ſouth through Northumberland and Cumberland; and were formerly the borders or boundaries between England and Scotland, where many a bloody battle has been fought between the two nations; one of which is recorded in the ballad of Chevy-chaſe. Theſe hills are the firſt land diſcovered by ſailors in coming from the eaſt into Scotland.

CHEVISANCE, in *Law*, denotes an agreement or compoſition, as an end or order ſet down between a creditor and his debtor, &c. In the ſtatutes, this word is moſt commonly uſed for an unlawful bargain or contract.

CHEVREAU, URBAN, a learned writer, born at Lundun in 1613. He diſtinguiſhed himſelf in his youth by his knowledge of the belles lettres; and became ſecretary of ſtate to Queen Chriſtina of Sweden. Several German princes invited him to their courts; and Charles Lewis, the elector palatine, retained him under the title of counſellor. After the death of that prince, he returned to France, and became preceptor to the duke of Maine. At length retiring to London, he died there in 1701, aged 88. He was the author of ſeveral books; and amongſt others of an Univerſal Hiſtory, which has been often reprinted.

CHEVRON, or Cheveron, in *Heraldry*. See Heraldry.

CHEWING-balls, a kind of balls made of aſafœtida, liver of antimony, bay-wood, juniper-wood, and pellitory of Spain; which being dried in the ſun, and wrapped in a linen cloth, are tied to the bit of the bridle for the horſe to chew; they create an appetite; and it is ſaid, that balls of Venice-treacle may be uſed in the ſame manner with good ſucceſs.

CHEYKS. See Bengal, N° 17.

CHEYNE, Dr George, a phyſician of great learning and abilities, born in Scotland in 1671, and educated at Edinburgh under the great Dr Pitcairn. He paſſed his youth in cloſe ſtudy, and with great temperance; but coming to ſettle at London, when about 30, and finding the younger gentry and free-livers to be the moſt eaſy of acceſs and moſt ſuſceptible of friendſhip, he changed on a ſudden his former manner of living, in order to force a trade, having obſerved this method to ſucceed with ſome others. The conſequence was, that he grew daily in bulk, and in intimacy with his gay acquaintance; ſwelling to ſuch an enormous ſize, that he exceeded 32 ſtone weight; and he was forced to have the whole ſide of his chariot made open to receive him into it; he grew ſhort-breathed, lethargic, nervous, and ſcorbutic; ſo that his life became an intolerable burden. In this deplorable condition, after having tried all the power of medicine in vain, he reſolved to try a milk and vegetable diet; the good effects of which quickly appeared. His ſize was reduced almoſt a third; and he recovered his ſtrength, activity, and chearfulneſs, with the perfect uſe of all his faculties. In ſhort, by a regular adherence to this regimen, he lived to a mature period, dying at Bath in 1742, aged 72. He wrote ſeveral treatiſes that were well received; particularly, "An Eſſay on Health and Long Life;" and "The Engliſh Malady, or a Treatiſe of Nervous Diſeaſes;" both the reſult of his own experience. In ſhort, he had great reputation in his own time, both as a practitioner and as a writer; and moſt of his pieces paſſed through ſeveral editions. He is to be ranked among thoſe phyſicians who have accounted for the operations of medicines and the morbid alterations which take place in the human body, upon mechanical principles. A ſpirit of piety and of benevolence, and an ardent zeal for the intereſts of virtue, are predominant throughout his writings. An amiable candour and ingenuouſneſs are alſo diſcernible; and which led him to retract with readineſs whatever appeared to him to be cenſurable in what he had formerly advanced. Some of the metaphyſical notions which he has introduced into his books may perhaps juſtly be thought fanciful and ill-grounded; but there is an agreeable vivacity in his productions, together with much openneſs and frankneſs, and in general great perſpicuity.

CHIABRERA, Gabriel, eſteemed the Pindar of Italy, was born at Savona in 1552, and went to ſtudy at Rome. The Italian princes, and Urban VIII. gave him public marks of their eſteem. He wrote a great number of poems; but his lyric verſes are moſt admired. He died at Savona, in 1638, aged 86.

CHIAN earth, in *Pharmacy*, one of the medicinal earths of the ancients, the name of which is preſerved in the catalogues of the materia medica, but of which nothing more than the name has been known for many ages in the ſhops.

It is a very denſe and compact earth; and is ſent hither in ſmall flat pieces from the iſland of Chios, in which it is found in great plenty at this time. It ſtands recommended to us as an aſtringent. They tell us, it is the greateſt of all coſmetics; and that it gives a whiteneſs and ſmoothneſs to the ſkin, and prevents wrinkles, beyond any of the other ſubſtances that have been celebrated for the ſame purpoſes.

CHIAOUS, a word in the original Turkiſh, ſignifying "envoys," are officers to the number of five or ſix hundred in the grand ſignior's court, under the command of a chiaous baſchi. They frequently meet in the grand viſir's palace, that they may be in readineſs to execute his orders, and carry his diſpatches into all the provinces of the empire. The chiaous baſchi aſſiſts at the divan, and introduces thoſe who have buſineſs there.

CHIAPA, the capital of a province of the ſame name in Mexico, ſituated about 300 miles eaſt of Acapulco. W. Long. 98. 0. N. Lat. 16. 30.

Chiapa el Real, a town of Mexico, in a province of the ſame name, with a biſhop's ſee. Its principal trade conſiſts in chocolate-nuts, cotton, and ſugar. W. Long. 98. 35. N. Lat. 16. 20.

Chiapas de los Indos, a large and rich town of North America, in Mexico, and in a province of the ſame name. The governor and moſt of the inhabitants are originally Americans. W. Long. 98. 5. N. Lat. 15. 6.

CHIARI, Joseph, a celebrated Italian painter, was the diſciple of Carlo Maratti; and adorned the churches and palaces of Rome with a great number of fine paintings. He died of an apoplexy in 1727, aged 73.

Chiari, a town of Italy, in the province of Breſcia, and territory of Venice, 7 miles weſt of Breſcia, and 27 eaſt of Milan. Here the Imperialiſts gained a victory over the French in 1701. E. Long. 18. 18. N. Lat. 45. 30.

CHIARO scuro. See *Claro-Obſcuro*.

CHIAVENNA, a handſome, populous, and large town of Swiſſerland, in the county of the Griſons. It is a trading place, eſpecially in wine and delicate fruits. The governor's palace and the churches are very magnificent, and the inhabitants are Roman Catholics. It was at one period during the late conteſt with France, the ſcene of much carnage and bloodſhed. It is ſeated near the lake Como. E. Long. 9. 29. N. Lat. 46. 15.

CHIAUSI, among the Turks, officers employed in executing the vizirs, baſhaws, and other great men: the orders for doing this, the grand ſignior ſends them wrapped up in a black cloth; on the reception of which they immediately perform their office.

CHICANE, or Chicanery, in *Law*, an abuſe of judiciary proceeding, tending to delay the cauſe, to puzzle the judge, or impoſe upon the parties.

Chicane, in the ſchools, is applied to vain ſophiſms, diſtinctions, and ſubtleties, which protract diſputes, and obſcure the truth.

CHICHESTER, the capital city of the county of Suſſex, was built by Ciſſa, the ſecond king of the South Saxons, and by him called *Ciſſan Ceſter*. It is ſurrounded with a wall, which has four gates anſwering to the four cardinal points; from which run two ſtreets, that croſs one another in the middle and form a ſquare, where the market is kept, and where there is a fine ſtone piazza built by Biſhop Read. The ſpace between the weſt and ſouth gates is taken up with the cathedral church and the biſhop's palace. It has five pariſh-churches; and is ſeated on the little river Lavant, which waſhes it on all ſides except the north. This city would have been in a much more flouriſhing condition if it had been built by the ſea-ſide; however, the inhabitants have endeavoured to ſupply this defect in ſome meaſure, by cutting a canal from the city down to the bay. The principal manufactures of the town are malt and needles. The market of Chicheſter is noted for fiſh, wheat, barley, malt, and oats; the fineſt lobſters in England are bred in the Lavant; and it is obſervable, that this river, unlike moſt others, is very low in winter, but in ſummer often overflows its banks. Chicheſter is a city and county of itſelf; it is governed by a mayor, recorder, aldermen, common-council without limitation, and four juſtices of the peace choſen out of the aldermen; and it ſends two members to parliament. It is a biſhop's ſee. The cathedral church was anciently dedicated to St Peter. It was new built by Radulph, the twenty-fifth biſhop; but being deſtroyed by fire, it was again built by Seffridus II. the twenty-ninth biſhop. This ſee hath yielded to the church two ſaints, and to the nation three lord chancellors, two almoners, and one chancellor to the univerſity of Oxford. Anciently the biſhops of Chicheſter were confeſſors to the queens of England. This dioceſe contains the whole of the county of Suſſex (excepting 22 pariſhes, peculiars of the archbiſhop of Canterbury,) wherein are 250 pariſhes, whereof 112 are impropriated. It hath two archdeacons, viz. of Chicheſter and Lewes; is valued in the king's books at 667l. 1s. 3d. and is computed to be worth annually 2600l. The tenths of the whole clergy is 287l. 2s. 0¼d. To the cathedral belong a biſhop, a dean, two archdeacons, a treaſurer, a chancellor, thirty-two prebendaries, a chanter, twelve vicars-choral, and other officers. W. Long. 50. N. Lat. 50. 50.

CHICK, or Chicken, in *Zoology*, denotes the young of the gallinaceous order of birds, eſpecially the common hen. See Phasianus, Ornithology *Index*.

Chick-Weed. See Alsine, Botany *Index*.

Chicken-Pox. See Medicine *Index*.

CHICKLING-pea, a name given to the Lathyrus. See Botany *Index*.

CHICUITOS, a province of South America, in the government of Santa Cruz de la Sierra. The chief riches conſiſt of honey and wax; and the original inhabitants are very voluptuous, yet very warlike They maintained bloody wars with the Spaniards till 1690; ſince which, ſome of them have become Chriſtians. It is bounded by la Plata on the north-eaſt, and by Chili on the weſt.

CHIDLEY, or Chimley, a market-town of Devonſhire, ſituated in W. Long. 4. 0. N. Lat. 51. 0.

CHIEF, a term ſignifying the head or principal part of a thing or perſon. Thus we ſay, the chief of a party, the chief of a family, &c. The word is formed of the French *chef*, "head;" of the Greek κεφαλη, *caput*, "head;" though Menage derives it from the Italian *capo*, formed of the Latin, *caput*.

Chief, in *Heraldry*, is that which takes up all the upper part of the eſcutcheon from ſide to ſide, and repreſents a man's head. *In chief*, imports ſomething borne in the chief part or top of the eſcutcheon.

CHIEFTAIN, denotes the captain or chief of any claſs, family, or body of men. Thus the chieftains or chiefs of the Highland clans, were the principal noblemen or gentlemen of their reſpective clans. See Clans.

CHIELEFA, a ſtrong town of Turkey in Europe, in the Morea. It was taken by the Venetians in 1685; but after that the Turks retook it, with all the Morea. E. Long. 22. 21. N. Lat. 26. 50.

CHIGI, Fabio, or Pope Alexander VII. was born at Sienna in 1599. His family finding him a hopeful youth, ſent him early to Rome, where he ſoon engaged in a friendſhip with the marquis Pallavicini, who recommended him ſo effectually to Pope Urban VIII. that he procured him the poſt of inquiſitor at Malta. He was ſent vice-legate to Ferrara, and afterward nuncio into Germany: there he had an opportunity of diſplaying his intriguing genius; for he was mediator at Munſter, in the long conference held to conclude a peace with Spain. Cardinal Mazarin had ſome reſentment againſt Chigi, who was ſoon after made a cardinal and ſecretary of ſtate by Innocent X. but his reſentment was ſacrificed to political views. In 1655, when a pope was to be choſen, Cardinal Sacchetti, Mazarin's great friend, finding it was impoſſible for him to be raiſed into St Peter's chair, becauſe of the powerful oppoſition made by the Spaniſh faction, deſired Cardinal Mazarin to conſent to Chigi's exaltation. His requeſt was granted, and he was elected pope by the votes of all the 64 cardinals who were in the conclave: an unanimity of which there are but few inſtances in the election of popes. He ſhowed uncommon humility at his election, and at firſt forbade all his relations to come to Rome without his leave; but he ſoon became more favourable to his nephews, and loaded them with favours. It is aſſerted that he had once a mind to turn Proteſtant. The newſpapers in Holland beſtowed great encomiums upon him; and acquainted the world that he did not approve of the cruel perſecutions of the Waldenſes in Piedmont. There is a volume of his poems extant. He loved the *Belles-Lettres*, and the converſation of learned men. He was extremely fond of ſtately buildings: the grand plan of the college *Della Sapienza*, which he finiſhed, and adorned with a fine library, remains a proof of his taſte in architecture. He died in 1667.

CHILBLAIN *(pernio.)* in *Medicine*, a tumor affecting the feet and hands; accompanied with an inflammation, pains, and ſometimes an ulcer or ſolution of continuity: in which caſe it takes the denomination of *chaps* on the hands, and of *kibes* on the heels. Chilblain is compounded of *chill* and *blain*; *q. d.* a blain or ſore contracted by cold. *Pernio* is the Latin name adopted by phyſicians; and is derived by Voſſius from *perna*, "a gammon of bacon," on account of ſome reſemblance. *Chap* alludes to *gape*, both in ſound and appearance. *Kibes*, in Welch *kibwst*, may be derived from the German *kerben*, "to cut;" the ſkin, when broke, appearing like a cut.

Chilblains are occaſioned by exceſſive cold ſtopping the motion of the blood in the capillary arteries. See the article Pernio.

CHILD, a term of relation to *parent*. See Parent and Children.

Bartholine, Paré, Licetus, and many other writers, give an account of a petrified child, which has ſeemed wholly incredible to ſome people. The child, however, which they deſcribe, is ſtill in being; and is kept as a great rarity in the king of Denmark's muſeum at Copenhagen. The woman who was big with this, lived at Sens in Champagne in the year 1582; it was cut out of her belly, and was univerſally ſuppoſed to have lain there about 20 years. That it is a real human fœtus, and not artificial, is evident to the eyes of any obſerver; and the upper part of it, when examined, is found to be of a ſubſtance reſembling the gypſum or ſtone whereof they made the plaſter of Paris: the lower part is much harder, the thighs and buttocks being a perfect ſtone of a reddiſh colour, and as hard as common quarry ſtone: the grain and ſurface of this part appears exactly like that of the calculi or ſtones taken out of human bladders: and the whole ſubſtance, examined ever ſo nearly, and felt ever ſo carefully, appears to be abſolute ſtone. It was carried from Sens to Paris, and there purchaſed by a goldſmith of Venice; and Frederic III. king of Denmark purchaſed it of this man at Venice for a very large ſum, and added it to his collection of rarities.

Child Bed. } See Midwifery.
Child Birth. }

Child Wit, a power to take a fine of a bond-woman unlawfully gotten with child, that is, without conſent of her lord. Every reputed father of a baſe child got within the manor of Writtel in Eſſex, pays to the lord a fine of 3s. 4d.; where, it ſeems, childwit extends to free as well as bond-women.

CHILDERMAS-day, or *Innocents Day*, an anniverſary held by the church of England on the 28th of December, in commemoration of the children of Bethlehem maſſacred by order of Herod.

CHILDREN, the plural of Child.

Mr Derham computes, that marriages, one with another, produce four children not only in England but in other parts alſo.

In the genealogical hiſtory of Tuſcany, written by Gamarini, mention is made of a nobleman of Sienna, named Pichi, who of three wives had 150 *children*; and that, being ſent ambaſſador to the pope and the emperor, he had 48 of his ſons in his retinue. In a monument in the church-yard of St Innocent, at Paris, erected to a woman who died at 88 years of age; it is recorded, that ſhe might have ſeen 288 *children* directly iſſued from her. This exceeds what Hakewell relates of Mrs Honeywood, a gentlewoman of Kent, born in the year 1527, and married at 16 to her only huſband R. Honeywood of Charing, Eſq. and died in her 93d year. She had 16 *children* of her own body; of which three died young, and a fourth had no iſſue: yet her *grandchildren*, in the ſecond generation, amounted to 114; in the third, to 228; though in the fourth they fell to 9. The whole number ſhe might have ſeen in her life-time, being 367. 16+14+228+9=367. So that ſhe could ſay the ſame as the diſtich does of one Dalburg's family at Bazil:

1 2 3 4
Mater ait natæ, dic natæ filia natam,
5 6
Ut moneat, natæ plangere, filiolam.

Management of Children. See Infant.

Overlaying of Children, is a misfortune that frequently happens; to prevent which, the Florentines have contrived an inſtrument called *arcuccio*. See Arcuccio.

Children are, in *Law*, a man's iſſue begotten on his wife. As to *illegitimate children*, ſee Bastard.

For the legal duties of parents to their children, ſee the articles Parent and Bastard.

As to the duties of children to their parents, they ariſe from a principle of natural juſtice and retribution. For to thoſe who gave us exiſtence, we naturally owe ſubjection and obedience during our minority, and honour and reverence ever after; they who protected the weakneſs of our infancy, are entitled to our protection in the infirmity of their age; they who by ſuſtenance and education have enabled their offſpring to proſper, ought, in return, to be ſupported by that offſpring, in caſe they ſtand in need of aſſiſtance. Upon this principle proceed all the duties of children to their parents, which are enjoined by poſitive laws. And the Athenian laws carried this principle into practice with a ſcrupulous kind of nicety, obliging all children to provide for their father when fallen into poverty; with an exception to ſpurious children, to thoſe whoſe chaſtity had been proſtituted with conſent of their father, and to thoſe whom he had not put in any way of gaining a livelihood. The legiſlature, ſays Baron Monteſquieu, conſidered, that, in the firſt caſe, the father, being uncertain, had rendered the natural obligation precarious; that, in the ſecond caſe, he had ſullied the life he had given, and done his children the greateſt of injuries, in depriving them of their reputation; and that, in the third caſe, he had rendered their life (ſo far as in him lay) an inſupportable burden, by furniſhing them with no means of ſubſiſtence.

Our laws agree with thoſe of Athens, with regard to the firſt only of theſe particulars, the caſe of ſpurious iſſue. In the other caſes, the law does not hold the tie of nature to be diſſolved by any miſbehaviour of the parent; and, therefore, a child is equally juſtifiable in defending the perſon, or maintaining the cauſe or ſuit, of a bad parent as of a good one; and is equally compellable, if of ſufficient ability, to maintain and provide for a wicked and unnatural progenitor, as for one who has ſhown the greateſt tenderneſs and parental piety. See further the article *Filial Affection*.

CHILI, a province of South America, bounded by Peru on the north, by the province of La Plata on the eaſt, by Patagonia on the ſouth, and by the Pacific ocean on the weſt, lying between 75 and 85 degrees of weſt longitude; and between 25 and 45 of ſouth latitude; though ſome comprehend in this province Patagonia and Terra del Fuego.

The firſt attempt of the Spaniards upon this country was made by Almagro in the year 1535, after he and Pizarro had completed the conqueſt of Peru. He ſet out on his expedition to Chili with a conſiderable body of Spaniards and auxiliary Indians. For 200 leagues he was well accommodated with every neceſſary by the Indians, who had been ſubjects of the emperors of Peru: but reaching the barren country of Charcas, his troops became diſcontented through the hardſhips they ſuffered; which determined Almagro to climb the mountains called *Cordilleras;* in order to get the ſooner into Chili; being ignorant of the invaluable mines of Potoſi, contained in the province of Charcas, where he then was. At that time the Cordilleras were covered with ſnow, the depth of which obliged him to dig his way through it. The cold made ſuch an impreſſion on his naked Indians, that it is computed no leſs than 10,000 of them periſhed on theſe dreadful mountains, 150 of the Spaniards ſharing the ſame fate; while many of the ſurvivors loſt their fingers and toes through the exceſs of cold. At laſt, after encountering incredible difficulties, Almagro reached a fine, temperate, and fertile plain on the oppoſite ſide of the Cordilleras, where he was received with the greateſt kindneſs by the natives. Theſe poor ſavages, taking the Spaniards for deputies of their god Virachoca, immediately collected for them an offering of gold and ſilver worth 290,000 ducats: and ſoon after brought a preſent to Almagro worth 300,000 more. Theſe offerings only determined him to conquer the whole country as ſoon as poſſible. The Indians among whom he now was, had acknowledged the authority of the Peruvian incas, or emperors, and conſequently gave Almagro no trouble. He therefore marched immediately againſt thoſe who had never been conquered by the Peruvians, and inhabited the ſouthern parts of Chili. Theſe ſavages fought with great reſolution, and diſputed every inch of ground; but in five months time the Spaniards had made ſuch progreſs, that they muſt infallibly have reduced the whole province in a very little time, had not Almagro returned to Peru, in conſequence of a commiſſion ſent him from Spain.

In 1540, Pizarro having overcome and put Almagra to death, ſent into Chili, Baldivia or Valdivia, who had learned the rudiments of war in Italy, and was reckoned one of the beſt officers in the Spaniſh ſervice. As he penetrated ſouthwards, however, he met with much oppoſition; the confederated caziques frequently gave him battle, and diſplayed great courage and reſolution; but could not prevent him from penetrating to the valley of Maſiocho, which he found incredibly fertile and populous. Here he founded the city of St Jago; and, finding gold mines in the neighbourhood, forced the Indians to work in them: at the ſame time building a caſtle for the ſafety and protection of his new colony. The natives, exaſperated at this ſlavery, immediately took up arms; attacked the fort; and though defeated and repulſed, ſet fire to the outworks, which contained all the proviſions of the Spaniards. Nor were they diſcouraged by this and many other defeats, but ſtill continued to carry on the war with vigour. At laſt, Valdivia, having overcome them in many battles, forced the inhabitants of the vale to ſubmit; upon which he immediately ſet them to work in the mines of Quilotta. This indignity offered to their countrymen redoubled the fury of thoſe who remained at liberty. Their utmoſt efforts, however, were as yet unable to ſtop Valdivia's progreſs. Having croſſed the large rivers Maulle and Hàta, he traverſed a vaſt tract of country, and founded the city of La Conception on the South-ſea coaſt. He erected fortreſſes in ſeveral parts of the country, in order to keep the natives in awe; and built the city called *Imperial*, about 40 leagues to the ſouthward of Conception. The Spaniſh writers ſay, that the neighbouring valley contained 80,000 inhabitants of a peaceable diſpoſition; and who were even ſo tame as to ſuffer Valdivia to parcel out their lands among his followers, while they themſelves remained in a ſtate of inactivity. About 16 leagues to the eaſtward of Imperial, the Spaniſh general laid the foundations of the city *Villa Rica*, ſo called on account of the rich gold mines he found there. But his ambition and avarice had now involved him in difficulties from which he could never be extricated: He had extended his conqueſts beyond what his ſtrength was capable of maintaining. The Chileſians were ſtill as deſirous as ever of recovering their liberties. The horſes, fire-arms, and armour of the Spaniards, indeed, appeared dreadful to them; but thoughts of endleſs ſlavery were ſtill more ſo. In the courſe of the war they had diſcovered that the Spaniards were vulnerable and mortal men like themſelves; they hoped, therefore, by dint of their ſuperiority in numbers, to be able to expel the tyrannical uſurpers. Had all the nations joined in this reſolution, the Spaniards had certainly been exterminated; but ſome of them were of a pacific and fearful diſpoſition, while others conſidered ſervitude as the greateſt of all poſſible calamities. Of this laſt opinion were the Araccans, the moſt intrepid people in Chili, and who had given Valdivia the greateſt trouble. They all roſe to a man, and choſe Capaulican, a renowned hero among them, for their leader. Valdivia however received notice of their revolt ſooner than they intended he ſhould, and returned with all expedition to the vale of Araccea; but before he arrived, 14,000 of the Chileſians were there aſſembled under the conduct of Capaulican. He attacked them with his cavalry, and forced them to retreat into the woods; but could not obtain a complete victory, as they kept continually ſallying out and haraſſing his men. At laſt Capaulican, having obſerved that fighting with ſuch a number of undiſciplined troops only ſerved to contribute to the defeat and confuſion of the whole, divided his forces into bodies of 1000 each. Theſe he directed to attack the enemy by turns; and, though he did not expect that a ſingle thouſand would put them to flight, he directed them to make as long a ſtand as they could; when they were to be relieved and ſupported by another body; and thus the Spaniards would be at laſt wearied out and overcome. The event fully anſwered his expectations. The Chileſians maintained a fight for ſeven or eight hours, until the Spaniards, growing faint for want of refreſhment, retired precipitately. Valdivia ordered them to poſſeſs a paſs at ſome diſtance from the field, to ſtop the purſuit; but this deſign being diſcovered to the Chileſians by the treachery of his page, who was a native of that country, the Spaniards were ſurrounded on all ſides, and cut in pieces by the Indians. The general was taken and put to death; ſome ſay with the tortures uſually inflicted by thoſe ſavages on their priſoners; others, that he had melted gold poured down his throat; but all agree, that the Indians made flutes and other inſtruments of his bones, and preſerved his ſkull as a monument of their victory, which they celebrated by an annual feſtival. After this victory the Chileſians had another engagement with their enemies; in which alſo they proved victorious, defeating the Spaniards with the loſs of near 3000 men; and upon this they bent their whole force againſt the colonies. The city of Conception, being abandoned by the Spaniards, was taken and deſtroyed: but the Indians were forced to raiſe the ſiege of Imperial; and their progreſs was at laſt ſtopped by Garcia de Mendoza, who defeated Capaulican, took him priſoner, and put him to death. No defeats, however, could diſpirit the Chileſians. They continued the war for 50 years; and to this day they remain unconquered, and give the Spaniards more trouble than any other American nation. Their moſt irreconcileable enemies are the inhabitants of Araccea and Tucapel, thoſe to the ſouth of the river Bobia, or whoſe country extends towards the Cordilleras.—The manners of theſe people greatly reſemble thoſe of North America, which we have already deſcribed under the article America; but they ſeem to have a more warlike diſpoſition. It is a conſtant rule with the Chileſians never to ſue for peace. The Spaniards are obliged not only to make the firſt overtures, but to purchaſe it by preſents. They have at laſt been obliged to abandon all thoughts of extending their conqueſts, and reduced to cover their frontiers by erecting forts at proper diſtances.

The Spaniſh colonies in Chili are diſperſed on the borders of the South-ſea. They are parted from Peru by a deſert of 80 leagues in breadth; and bounded by the iſland of Chiloe, at the extremity next the ſtraits of Magellan. There are no ſettlements on the coaſt, except thoſe of Baldivia, Conception iſland, Valparaiſo, and Coquimbo or La Serena, which are all ſea-ports. In the inland country is St Jago, the capital of the colony. There is no culture nor habitation at any diſtance from theſe towns. The buildings in the whole province are low, made of unburnt brick; and moſtly thatched. This practice is obſerved on account of the frequent earthquakes; and is properly adapted to the nature of the climate, as well as the indolence of the inhabitants.

The climate of Chili is one of the moſt wholeſome in the whole world. The vicinity of the Cordilleras gives it ſuch a delightful temperature as could not otherwiſe be expected in that latitude. Though gold mines are found in it, their richneſs has been too much extolled; their produce never exceeds 218,750l. The ſoil is prodigiouſly fertile. All the European fruits have improved in that happy climate. The wine would be excellent if nature were properly aſſiſted by art: and the corn-harveſt is reckoned a bad one when it does not yield a hundred fold. With all theſe advantages, Chili has no direct intercourſe with the mother-country. Their trade is confined to Peru, Paraguay, and the ſavages on their frontiers. With theſe laſt they exchange their leſs valuable commodities, for oxen, horſes, and their own children, whom they are ready to part with for the moſt trifling things. This province ſupplies Peru with great plenty of hides, dried fruit, copper, ſalt-meat, horſes, hemp, lard, wheat, and gold. In exchange it receives tobacco, ſugar, cocoa, earthen-ware, woollen cloth, linen, hats, made at Quito, and every article of luxury brought from Europe. The ſhips ſent from Callao on this traffic were formerly bound to Conception Bay, but now come to Valparaiſo. The commerce between this province and Paraguay is carried on by land, though it is a journey of 300 leagues, 40 of which lie through the ſnows and precipices of the Cordilleras; but if it was carried on by ſea, they muſt either paſs the ſtraits of Magellan or double Cape Horn, which the Spaniards always avoid as much as poſſible. To Paraguay are ſent ſome woollen ſtuffs called *ponchos*, which are uſed for cloaks; alſo wines, brandy, oil, and chiefly gold. In return they receive wax, a kind of tallow fit to make ſoap, European goods, and negroes.

Chili is governed by a chief, who is abſolute in all civil, political, and military affairs, and is alſo independent of the viceroy. The latter has no authority except when a governor dies; in which caſe he may appoint one in his room for a time, till the mother-country names a ſucceſſor. If, on ſome occaſions, the viceroy has interfered in the government of Chili, it was when he has been either authorized by a particular truſt repoſed in him by the court, or by the deference paid to the eminence of his office; or when he has been actuated by his own ambition to extend his authority. In the whole province of Chili there are not 20,000 white men, and not more than 60,000 negroes, or Indians, able to bear arms. The military eſtabliſhment amounted formerly to 2000 men; but the maintaining of them being found too expenſive, they were reduced to 500 at the beginning of this century.

CHILIAD, an aſſemblage of ſeveral things ranged by thouſands. The word is formed of the Greek χιλιας, *mille*, "a thouſand."

CHILIAGON, in *Geometry*, a regular plane figure of 100 ſides and angles. Though the imagination cannot form the idea of ſuch a figure, yet we may have a very clear notion of it in the mind, and can eaſily demonſtrate that the ſum of all its angles is equal to 1996 right ones: for the internal angles of every plane figure are equal to twice as many right ones as the figure hath ſides, except thoſe four which are about the centre of the figure, from whence it may be reſolved into as many triangles as it has ſides. The author of *l'Art de Penſer*, p. 44. has brought this inſtance to ſhow the diſtinction between imagination and conceiving.

CHILIARCHA, or Chiliarchus, an officer in the armies of the ancients, who had the command of a thouſand men.

CHILIASTS, in church-hiſtory. See Millenarians.

CHILLINGWORTH, William, an eminent divine

vine of the church of England, was born at Oxford in 1602, and bred there. He made early great proficiency in his ſtudies, being of a very quick genius. He was an expert mathematician, as well as an able divine, and a very good poet. Study and converſation at the univerſity turning upon the controverſy between the church of England and that of Rome, on account of the king's marriage with Henrietta daughter to Henry IV. king of France, Mr Chillingworth forſook the church of England, and embraced the Romiſh religion. Dr Laud, then biſhop of London, hearing of this, and being greatly concerned at it, wrote Mr Chillingworth; who expreſſing a great deal of candour and impartiality, that prelate continued to correſpond with him. This ſet Mr Chillingworth on a new inquiry; and at laſt determined him to return to his former religion. In 1634 he wrote a confutation of the arguments which had induced him to go over to the church of Rome. He ſpoke freely to his friends of all the difficulties that occurred to him; which gave occaſion to a groundleſs report, that he had turned Papiſt a ſecond time, and then Proteſtant again. His return to the communion of the church of England made a great noiſe, and engaged him in ſeveral diſputes with thoſe of the Romiſh perſuaſion. But in 1635 he engaged in a work which gave him a far greater opportunity to confute the principles of the church of Rome, and to vindicate the Proteſtant religion, under the title of "The religion of Proteſtants a ſafe Way to Salvation." Sir Thomas Coventry, lord keeper of the great ſeal, offering him preferment, Mr Chillingworth refuſed to accept it on account of his ſcruples with regard to the ſubſcription of the 39 articles. However, he at laſt ſurmounted theſe ſcruples; and being promoted to the chancellorſhip of the church of Sarum, with the prebend of Brixworth in Northamptonſhire annexed to it, he complied with the uſual ſubſcription. Mr Chillingworth was zealouſly attached to the royal party; and, in Auguſt 1643, was preſent in King Charles I.'s army at the ſiege of Glouceſter, where he adviſed and directed the making certain engines for aſſaulting the town. Soon after, having accompanied the Lord Hopton, general of the king's forces in the weſt, to Arundel caſtle in Suſſex, he was there taken priſoner by the parliamentary forces under the command of Sir William Waller, who obliged the caſtle to ſurrender. But his illneſs increaſing, he obtained leave to be conveyed to Chicheſter, where he was lodged at the biſhop's palace; and, after a ſhort ſickneſs, died in 1644. He hath left ſeveral excellent works behind him.

CHILMINAR. See Persepolis.

CHILO, one of the ſeven ſages of Greece, and of the ephori of Sparta the place of his birth, flouriſhed about 556 years before Chriſt. He was accuſtomed to ſay that there were three things very difficult: "To keep a ſecret; to know how beſt to employ our time; and to ſuffer injuries without murmuring." According to Pliny, it was he who cauſed the ſhort ſentence, *Know thyſelf*, to be written in letters of gold in the temple of Delphos. It is ſaid that he died with joy, while embracing his ſon, who had been crowned at the Olympic games.

CHILOE, an iſland lying near the coaſt of Chili, in South America, under the 43d degree of ſouth latitude. It is the chief of an archipelago of 40 iſlands, and its principal town is Caſtro. It rains here almoſt all the year, inſomuch that nothing but Indian corn, or ſome ſuch grain, that requires but little heat to ripen it, can ever come to perfection. They have excellent ſhell-fiſh, very good wild-fowl, hogs, ſheep, and beeves; as alſo a great deal of honey and wax. They carry on a trade with Peru and Chili; whither they ſend boards of cedar, of which they have vaſt foreſts.

CHILTENHAM, a town in Glouceſterſhire, ſix miles from Glouceſter; noted for its purgative chalybeate ſpring, which has rendered it of late years a place of faſhionable reſort. This water, which operates with great eaſe, is deemed excellent in ſcorbutic complaints, and has been uſed with ſucceſs in the gravel.

CHILTERN, a chain of chalky hills forming the ſouthern part of Buckinghamſhire, the northern part of the county being diſtinguiſhed by the name of the *Vale*. The air on theſe heights is extremely healthful: The ſoil, though ſtony, produces good crops of wheat and barley; and in many places it is covered with thick woods, among which are great quantities of beech.—*Chiltern* is alſo applied to the hilly parts of Berkſhire, and it is believed has the ſame meaning in ſome other counties. Hence the Hundreds lying in thoſe parts are called the *Chiltern Hundreds*.

Chiltern *Hundreds*, *Stewards of*. Of the hundreds into which many of the Engliſh counties were divided by King Alfred for the better government, the juriſdiction was originally veſted in peculiar courts; but came afterwards to be devolved to the county courts, and ſo remains at preſent; excepting with regard to ſome, as the *chilterns*, which have been by privilege annexed to the crown. Theſe having ſtill their own courts, a *ſteward* of thoſe courts is appointed by the chancellor of the exchequer, with a ſalary of 20s. and all fees, &c. belonging to the office: and this is deemed an appointment of ſuch profit, as to vacate a ſeat in parliament.

CHIMÆRA, a port town of Turkey in Europe, ſituated at the entrance of the gulf of Venice, in the province of Epirus, about 32 miles north of the city Corfu, near which are the mountains of Chimæra, which divide Epirus from Theſſaly. E. Long. 20. 40. N. Lat. 40. 20.

Chimæra, in fabulous hiſtory, a celebrated monſter, ſprung from Echidna and Typhon. It had three heads; that of a lion, a goat, and a dragon; and continually vomited flames. The fore parts of its body were thoſe of a lion, the middle was that of a goat, and the hinder parts were thoſe of a dragon. It generally lived in Lycia, about the reign of Jobates, by whoſe orders Bellerophon, mounted on the horſe Pegaſus, overcame it. This fabulous tradition is explained by the recollection that there was a burning mountain in Lycia, whoſe top was the reſort of lions on account of its deſolate wilderneſs; the middle which was fruitful, was covered with goats; and at the bottom the marſhy ground abounded with ſerpents. Bellerophon is ſaid to have conquered the Chimæra, becauſe he deſtroyed the wild beaſts on that mountain, and rendered it habitable. Plutarch ſays that it was the captain of ſome pirates who adorned their ſhips with the images of a lion, a goat, and a dragon.

By a *chimæra* among the philoſophers, is under-

CHIMES.

Fig. 1.
The Notes of the 100 Psalm tune.

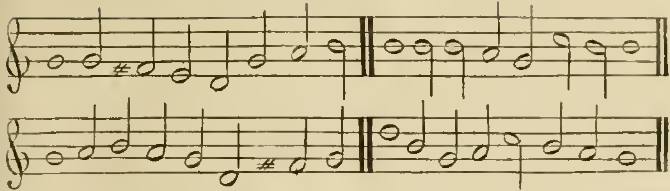
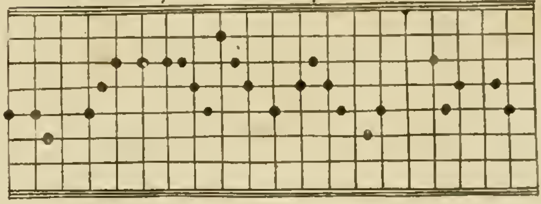


Fig. 2.
A Table for dividing the Chime barrel of the 100 Psalm tune.



CIPHER.

Fig. 3.

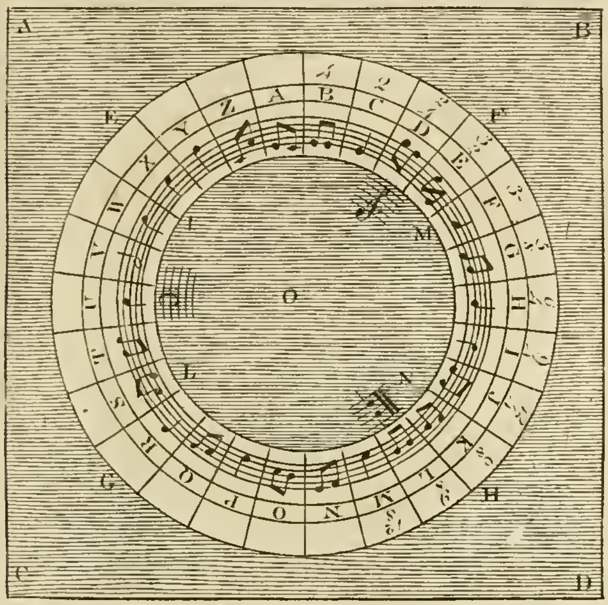


Fig. 4.

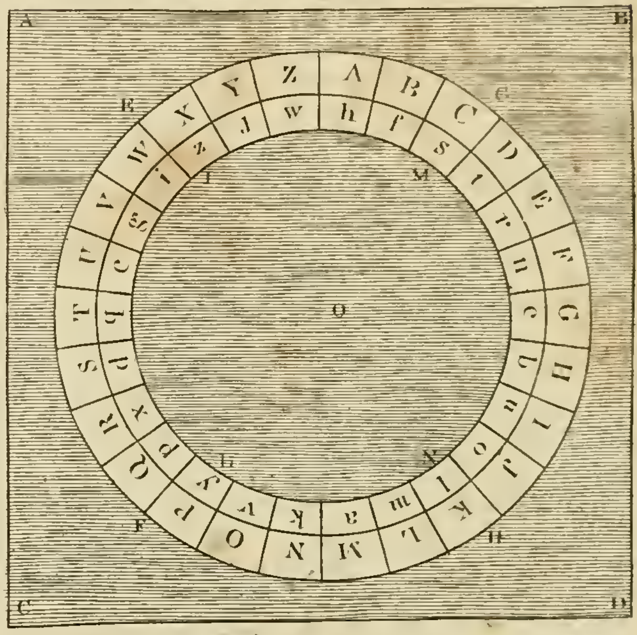


Fig. 5.

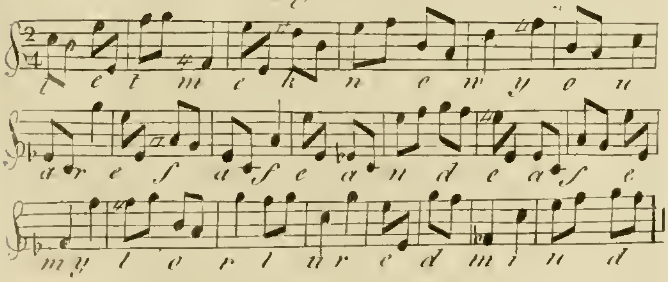


Fig. 6.

Ma un jve iumm svar
vgrè qr ed jve dbhmm
bhgr h yrkdurk hkt.—
jve ahj dqumm ahtr
h dbha vyyrduqurk.—

Fig. 7.

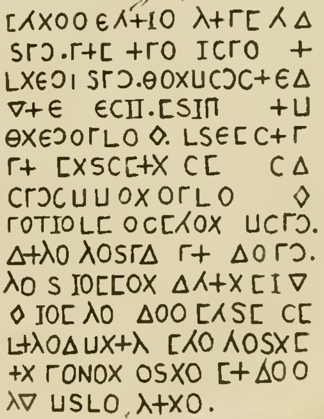


Fig. 8.

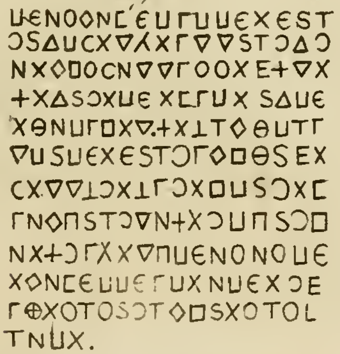
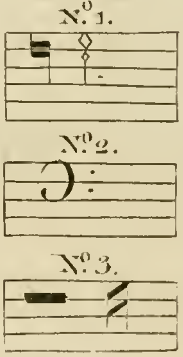


Fig. 9.



A. Bell Prin. Wal. Sculptor

ſtood a mere creature of the imagination, compoſed of ſuch contradictions and abſurdities as cannot poſſibly anywhere exiſt but in thought.

CHIMES of a Clock, a kind of periodical muſic, produced at equal intervals of time, by means of a particular apparatus added to a clock.

In order to calculate numbers for the chimes, and adapt the chime-barrel, it muſt be obſerved, that the barrel muſt turn round in the ſame time that the tune it is to play requires in ſinging. As for the chime-barrel, it may be made up of certain bars that run athwart it with a convenient number of holes punched in them to put in the pins that are to draw each hammer: and theſe pins, in order to play the time of the tune rightly, muſt ſtand uprightly, or hang down from the bar, ſome more, ſome leſs. To place the pins rightly, you may proceed by the way of changes on bells, viz. 1, 2, 3, 4; or rather make uſe of the muſical notes. Obſerve what is the compaſs of your tune, and divide the barrel accordingly from end to end.

Thus, in the examples on Plate CXLIV. each of the tunes is eight notes in compaſs; and accordingly the barrel is divided into eight parts. Theſe diviſions are ſtruck round the barrel; oppoſite to which are the hammer-tails.

We ſpeak here as if there were only one hammer to each bell, that it may be more clearly apprehended; but when two notes of the ſame ſound come together in a tune, there muſt be two hammers to the bell to ſtrike it: ſo that if in all the tunes you intend to chime of eight notes compaſs, there ſhould happen to be ſuch double notes on every bell, inſtead of eight you muſt have ſixteen hammers; and accordingly you muſt divide the barrel, and ſtrike ſixteen ſtrokes round it, oppoſite to each hammer tail; then you are to divide it round about into as many diviſions as there are muſical bars, ſemibreves, minims, &c. in the tune.

Thus the hundredth-pſalm tune has 20 ſemibreves, and each diviſion of it is a ſemibreve: the firſt note of it alſo is a ſemibreve; and, therefore, on the chime-barrel muſt be a whole diviſion, from five to five; as you may underſtand plainly, if you conceive the ſurface of a chime-barrel to be repreſented by the above figures, as if the cylindrical ſuperficies of the barrel were ſtretched out at length, or extended on a plane: and then ſuch a table, ſo divided, if it were to be wrapped round the barrel, would ſhow the places where all the pins are to ſtand in the barrel; for the dots running about the table are the places of the pins that play the tune.

Indeed, if the chimes are to be complete, you ought to have a ſet of bells to the gamut notes; ſo as that each bell having the true ſound of *ſol*, *la*, *mi*, *fa*, you may play any tune with its flats and ſharps; nay, you may by this means play both the baſe and treble with one barrel: and by ſetting the names of your bells at the head of any tune, that tune may eaſily be tranſferred to the chime-barrel, without any ſkill in muſic: but it muſt be obſerved, that each line in the muſic is three notes diſtant; that is, there is a note between each line, as well as upon it.

CHIMNEY, in *Architecture*, a particular part of a houſe, where the fire is made, having a tube or funnel to carry off the ſmoke. The word *chimney* comes from the French *cheminée;* and that from the Latin *caminata*, "a chamber wherein is a chimney;" *caminata*, again, comes from *caminus*; and that from the Greek καμινος, "chimney;" of καιω, *uro*, "I burn."

Chimneys are uſually ſuppoſed a modern invention; the ancients only making uſe of ſtoves: but Octavio Ferrari endeavours to prove chimneys in uſe among the ancients. To this end, he cites the authority of Virgil,

Et jam ſumma procul villarum culmina fumant:

and that of Appian, who ſays, "That of thoſe perſons proſcribed by the triumvirate, ſome hid themſelves in wells and common ſewers, and ſome on the tops of houſes and chimneys;" for ſo he underſtands καπνωδεις υπωροφιας, *fumaria ſub tecto poſita.* Add, that Ariſtophanes, in one of his comedies, introduces his old man, Polycleon, ſhut up in a chamber, whence he endeavours to make his eſcape by the *chimney.*

Chimneys, in Profeſſor Beckman's opinion, are comparatively of modern invention. We ſhall lay before our readers ſome obſervations from his elaborate diſſertation on this ſubject. He thus explains the above paſſage of Virgil.

"When the triumviri, ſays Appian *, cauſed thoſe who had been proſcribed by them to be ſought for by the military, ſome of them, to avoid the bloody hands of their perſecutors, hid themſelves in wells, and others, as Ferrarius tranſlates the words, *in fumaria ſub tecto, qua ſcilicet fumus è tecto evolvitur* (A). The true tranſlation, however, (ſays Mr Beckman) is *fumoſa cœnacula.* The principal perſons of Rome endeavoured to conceal themſelves in the ſmoky apartments of the upper ſtory under the roof, which in general, were inhabited only by poor people; and this ſeems to be confirmed by what Juvenal † expreſsly ſays, *Rarus venit in cœnacula miles.*

"Thoſe paſſages of the ancients which ſpeak of ſmoke riſing up from houſes, have with equal impropriety been ſuppoſed to allude to chimneys, as if the ſmoke could not make its way through doors and windows. Seneca ‡ writes, 'Laſt evening I had ſome friends with me, and on that account a ſtronger ſmoke was raiſed; not ſuch a ſmoke, however, as burſts forth from the kitchens of the great, and which alarms the watchmen, but ſuch a one as ſignifies that gueſts are arrived.' Thoſe whoſe judgments are not already warped by prejudice, will undoubtedly find the true ſenſe of theſe words to be, that the ſmoke forced its way through the kitchen windows. Had the houſes been built with chimney-funnels, one cannot conceive why the watchmen ſhould have been alarmed when they obſerved a ſtronger ſmoke than uſual ariſing from them; but as the kitchens had no convenience of that nature, an apprehenſion of fire, when extraordinary entertainments

* *De bellis civilib.* lib. iv. p. 962. Edit. Tollii.

† *Sat.* x. ver. 17.

‡ *Epiſt.* 64.

(A) Ες καπνωδεις υπωροφιας, η των τεγων ταις κεραμισι βυομεναις.

ments were to be provided in the houſes of the rich for large companies, ſeems to have been well founded; and on ſuch occaſions people appointed for that purpoſe were ſtationed in the neighbourhood to be conſtantly on the watch, and to be ready to extinguiſh the flames in caſe a fire ſhould happen. There are many other paſſages to be found in Roman authors of the like kind, which it is hardly neceſſary to mention; ſuch as that of Virgil [*],

Et jam ſumma procul villarum culmina fumant.

and the following words of Plautus [†], deſcriptive of a miſer:

Quin divum atque hominum clamat continuo fidem,
Suam rem periiſſe, ſeque eradicarier,
De ſuo tigillo fumus ſi qua exit foras.

"The paſſage of Ariſtophanes above alluded to, however, (ſays the profeſſor) which, according to the uſual tranſlation, ſeems to allude to a common chimney, can, in my opinion, eſpecially when we conſider the illuſtration of the ſcholiaſts, be explained alſo by a ſimple hole in the roof, as Reiſke has determined; and indeed this appears to be more probable, as we find mention made of a top or covering (τηλια) with which the hole was cloſed."

It has been ſaid that the inſtances of chimneys remaining among the ruins of ancient buildings are few, and that the rules given by Vitruvius for building them are obſcure; but it appears that there exiſt *no* remains of ancient chimneys; and that Vitruvius gives *no* rules, either obſcure or perſpicuous, for building what, in the modern acceptation of the word, deſerves the name of a chimney.

"The ancient maſon-work ſtill to be found in Italy does not determine the queſtion. Of the walls of towns, temples, amphitheatres, baths, aqueducts, and bridges, there are ſome though very imperfect remains, in which chimneys cannot be expected; but of common dwelling houſes none are to be ſeen, except at Herculaneum, and there no traces of chimneys have been diſcovered. The paintings and pieces of ſculpture which are preſerved, afford us as little information; for nothing can be perceived in them that bears the ſmalleſt reſemblance to a modern chimney.

"If there were no funnels in the houſes of the ancients to carry off the ſmoke, the directions given by Columella, to make kitchens ſo high that the roof ſhould not catch fire, was of the utmoſt importance. An accident of the kind, which that author ſeems to have apprehended, had almoſt happened at Beneventum, when the landord who entertained Mæcenas and his company was making a ſtrong fire in order to get ſome birds ſooner roaſted.

——————— *ubi ſedulus hoſpes*
Pæne arſit, macros dum turdos verſat in igne;
Nam vaga per veterem dilapſo flamma culinam
Vulcano ſummum properabat lambere tectam [‡].

Had there been chimneys in the Roman houſes, Vitruvius certainly would not have failed to deſcribe their conſtruction, which is ſometimes attended with conſiderable difficulties, and which is intimately connected with the regulation of the plan of the whole edifice. He does not, however, ſay a word on this ſubject; neither does Julius Pollux, who has collected with great care the Greek names of every part of a dwelling-houſe; and Grapaldus, who in later times made a collection of the Latin terms, has not given a Latin word expreſſive of a modern chimney [*]."

"*Caminus* ſignified, as far as I have been able to learn, firſt a chemical or metallurgic furnace, in which a crucible was placed for melting and refining metals; ſecondly, a ſmith's forge; and, thirdly, a hearth on which portable ſtoves or fire-pans were placed for warming the apartment. In all theſe, however, there appears no trace of a chimney." Herodotus relates (lib. viii. c. 137.), that a king of Libya, when one of his ſervants aſked for his wages, offered him in jeſt the ſun, which at that time ſhone into the houſe through an opening in the roof, under which the fire was perhaps made in the middle of the edifice. If ſuch a hole muſt be called a chimney, our author admits that chimneys were in uſe among the ancients, eſpecially in their kitchens; but it is obvious that ſuch chimneys bore no reſemblance to ours, through which the ſun could not dart his rays upon the floor of any apartment.

"However imperfect may be the information which can be collected from the Greek and Roman authors reſpecting the manner in which the ancients warmed their apartments, it neverthele ſs ſhews that they commonly uſed for that purpoſe a large fire-pan or portable ſtove, in which they kindled wood, and, when the wood was well lighted, carried it into the room, or which they filled with burning coals. When Alexander the Great was entertained by a friend in winter, as the weather was cold and raw, a ſmall fire baſon was brought into the apartment to warm it. The prince, obſerving the ſize of the veſſel, and that it contained only a few coals, deſired his hoſt in a jeering manner, to bring more wood or frankincenſe; giving him thus to underſtand that the fire was fitter for burning perfumes than to produce heat. Anacharſis, the Scythian philoſopher, though diſpleaſed with many of the Grecian cuſtoms, praiſed the Greeks, however, becauſe they ſhut out the ſmoke and brought only fire into their houſes [*]. We are informed by Lampridius, that the extravagant Heliogabalus cauſed to be burned in theſe ſtoves, inſtead of wood, Indian ſpiceries and coſtly perfumes [†]. It is alſo worthy of notice, that coals were found in ſome of the apartments of Herculaneum, as we are told by Winkelmann, but neither ſtoves nor chimneys.

It is well known to every ſcholar, that the uſeful arts of life were invented in the eaſt, and that the cuſtoms, manners, and furniture of eaſtern nations, have remained from time immemorial almoſt unchanged. In Perſia, which the late Sir William Jones ſeems to have conſidered as the original country of mankind, the methods employed by the inhabitants for warming themſelves have a great reſemblance to thoſe employed by the ancient Greeks and Romans for the ſame purpoſe. According to De la Valle, the Perſians make fires in their apartments, not in chimneys as we do, but in ſtoves in the earth, which they call *tennor*. "Theſe ſtoves conſiſt of a ſquare or round hole, two ſpans or a little more in depth, and in ſhape not unlike an Italian caſk. That this hole may throw out heat ſooner, and with more ſtrength, there is placed in it an iron veſſel of the ſame ſize, which is either filled with burning coals, or a fire of wood and other inflammable ſubſtances is made in it. When this is done, they place over the hole or ſtove a wooden top, like a ſmall low table, and ſpread above it a large coverlet quilted with cotton, which hangs down on all ſides to the floor. This covering condenſes the heat, and cauſes it to warm the whole apartment. The people who eat or converſe there, and ſome who ſleep in it, lie down on the floor above the carpet, and lean, with their ſhoulders againſt the wall, on ſquare cuſhions, upon which they ſometimes alſo ſit; for the *tennor* is conſtructed in a place equally diſtant from the walls on both ſides. Thoſe who are not very cold only put their feet under the table or covering; but thoſe who require more heat can put their hands under it, or creep under it altogether. By theſe means the ſtove diffuſes over the whole body, without cauſing uneaſineſs to the head, ſo penetrating and agreeable a warmth, that I never in winter experienced any thing more pleaſant. Thoſe, however, who require leſs heat, let the coverlet hang down on their ſide to the floor, and enjoy without any inconvenience from the ſtove the moderately heated air of the apartment. They have a method alſo of ſtirring up or blowing the fire when neceſſary, by means of a ſmall pipe united with the tennor or ſtove under the earth, and made to project above the floor as high as one chooſes; ſo that the wind, when a perſon blows into it, becauſe it has no other vent, acts immediately upon the fire like a pair of bellows. When there is no longer occaſion to uſe this ſtove, both holes are cloſed up, that is to ſay, the mouth of the ſtove and that of the pipe which conveys the air to it, by a flat ſtone made for that purpoſe. Scarcely any appearance of them is then to be perceived, nor do they occaſion inconvenience, eſpecially in a country where it is always cuſtomary to cover the floor with a carpet, and where the walls are plaſtered. In many parts theſe ovens are uſed to cook victuals, by placing kettles over them. They are employed alſo to bake bread; and for this purpoſe they are covered with a large broad metal plate, on which the cake is laid; but if the bread is thick and requires more heat, it is put into the ſtove itſelf *."

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[*] *Eclog.* i. ver. 83.

[†] *Aulular.* act. ii. ſc. 4.

[‡] *Horat.* lib. i. ſat. 5.

[*] *Franciſci Marii Grapaldi de partibus ædium libri.*

[*] *Plutarch. Sympoſ.* lib. vi. 7. p. 692.

[†] *Æl. Lamprid. Vita Heliogab.* cap. 31.

The profeſſor farther obſerves, the oldeſt account of them which he finds is an inſcription at Venice, which relates, that in the year 1347 a great many chimneys were thrown down by an earthquake. It would appear, however, that in ſome places they had been in uſe for a conſiderable time before that period; for De Gataris, in his hiſtory of Padua, relates, that Franceſco de Carraro, lord of Padua, came to Rome in 1368, and finding no chimneys in the inn where he lodged, becauſe at that time fire was kindled in a hall in the middle of the floor, he cauſed two chimneys like thoſe which had *long* been uſed at Padua to be conſtructed by maſons and carpenters, whom he had brought along with him. Over theſe chimneys, the firſt ever ſeen at Rome, he affixed his arms, which were ſtill remaining in the time of De Gataris, who died of the plague in 1405.

Method of Building CHIMNEYS *that will not ſmoke.* Workmen have different methods of drawing up the funnels of chimneys, generally according to their own fancies and judgments, and ſometimes according to the cuſtoms of places. They are ſeldom directed by ſound and rational principles. It will be found for the moſt part, that the ſmoking of chimneys is owing to their being carried up narrower near the top than below, or ziz-zag, all in angles; in ſome caſes, indeed, it is owing to accidental cauſes; but, for the moſt part to thoſe two above mentioned. Where they are carried up in the pyramid or tapering form, eſpecially if the houſe be of a conſiderable height, it is ten to one but they ſometimes ſmoke. The air in the rooms, being rarefied, is forced into the funnel of the chimney, and receives from the fire an additional force to carry up the ſmoke. Now it is evident, that the further up the ſmoke flies, the leſs is the force that drives it, the ſlower it muſt move, and conſequently the more room in proportion it ſhould have to move in; whereas in the uſual way it has leſs, by the ſides of the chimney being gathered cloſer and cloſer together.

The method here propoſed of carrying up chimneys will be objected to by ſome thus: The wider a chimney is at the top, ſay they, the more liberty has the wind to blow down. Very true; but is it not reſiſted in going down, both by the form of the chimney and other evident cauſes, ſo that it muſt return again? In the other way, when the wind blows down, the reſiſtance being leſs, the wind and ſmoke are, if we may uſe the expreſſion, impriſoned, and make the ſmoke puff out below. This method has proved effectual after all others had failed; and that in a houſe placed in the worſt ſituation poſſible, namely, under a high mountain to the ſouthward, from which ſtrong blaſts blow down upon it. A vent was carried up without angles, as perpendicular as poſſible; and was made about three or four inches wider at top than at the bottom: the funnel was gathered in a throat directly above the fire-place, and ſo widening upwards. Since that time the houſe has not only ceaſed to ſmoke, but when the doors ſtand open, the draught is ſo ſtrong that it will carry a piece of paper out at the chimney head. See more on this ſubject and the improvements by Count Rumford under the article SMOKE.

CHIMNEY-Money, otherwiſe called *Hearth-money*, a duty to the crown on houſes. By ſtat. 14. Char. II. cap. 2. every fire-hearth and ſtove of every dwelling or other houſe, within England and Wales (except ſuch as pay not to church and poor), was chargeable with 2s. per annum, payable at Michaelmas and Lady-day to the king and his heirs and ſucceſſors, &c.; which payment was commonly called *chimney-money*. This tax, being much complained off as burdenſome to the people, has been ſince taken off, and others impoſed in its ſtead; among which that on windows has by ſome been eſteemed almoſt equally grievous.

CHIMPANZEE, in *Natural Hiſtory*. See SIMIA.

END OF THE FIFTH VOLUME.

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* *Hiſt. of Invent.* ii. 88.

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